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FRIEDRICH FÜLLEBORN

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The American Society of Parasitologists notes with deep regret the death on the 9th of September, 1933, of Professor Dr. Fülleborn, Director of the Institut für Schiffs- und Tropenkrankheiten in Hamburg. An honorary foreign member of the Society, a world figure in the field of tropical medicine and parasitology; his American colleagues bear tribute to his personal qualities and scientific attainments.

Friedrich Georg Hans Fülleborn was born at Kulm, the 13th of September, 1866. He studied medicine and science at Berlin. From the beginning of his second semester he assisted, first as Famulus and later as Volontärassistent, in the laboratory of Prof. Hans Virchow, an association which led to a close and lasting friendship between him and the son of the illustrious pathologist. After passing the Physicum examination he worked also with Professors Waldeyer and von Luschan, under whose influence he became much interested in anthropology. Before qualifying in the medical Staatsexamen his knowledge of subject-matter and maturity of judgment were so marked that on occasion he was requested to substitute for Prof. Rabl-Rückardt in the histological laboratory.

Even during his student days his interests were always wider and deeper than the limits of the medical curriculum. The causes, significance and relations of biological phenomena held a fascination for him. An independent and inquisitive type of mind and a prodigious capacity for work caused him to begin investigation while his associates were still laboring over their text books. His first researches were done on the development of the allantois in birds.

He was fortunate in beginning his scientific career during the golden age of academic freedom and scientific progress in Germany which attracted students from all parts of the world to the German universities. The studies of Gegenbauer, Fürbringer, Koelliker, Wiedersheim and others had made anatomy broadly comparative, and the successors of Johannes Müller, among whom may be listed Ludwig, Helmholtz, Du Bois-Reymond, Verworn, and Liebig, had made physiology a truly experimental science. The philosophy of the time accepted the dictum

that medicine is based on biological phenomena and that it can attain its highest development only by a thorough knowledge and wise application of broad biological principles. The greatest physicians were conducting fundamental researches on the nature of biological processes as they occur in lower organisms. Although his life was devoted to practical aspects of clinical medicine, Fülleborn always cherished the truly scientific attitude of mind. The clearness of vision, the comprehensiveness of treatment, and the resourcefulness of experimental procedure which characterize his work may be regarded as a heritage of his university training.

In 1894 he began a series of travels which helped to widen his outlook and orient his activities in the field of theoretical and applied biology. The first of these voyages, undertaken at the behest of the Königl. Preussischen Akademie der Wissenschaften, was devoted to an investigation of the development of the ganoid fishes of North America. From 1896–1900 he served as physician to troops in German East Africa with a special commission to pursue scientific studies. Here he made his first acquaintance with tropical medicine and parasitic diseases. Dependent largely upon his own resources and ingenuity, he achieved marked success as a physician and in addition made noteworthy observations on the natural history of the region. During the period 1898–1900 he held a special commission from the Königl. Preuss. Akad. to undertake faunal and ethnological investigations of the Nyassa district. His interest and industry in this undertaking are demonstrated by the fact that on his return to Germany in 1900 he brought back, among other things, 800 bird skins, many of them species new to science. His ethnological studies resulted in the publication of his (1902) "Beiträge zur physichen Anthropologie der Nord-Nyassaländer" and in a later (1906) beautifully illustrated monograph on "Das deutsche Nyassa- und RuwumaGebiet, Land und Leute," Nebst Bilderatlas (enthaltend 118 Lichtdrucktafeln und 2 Karten), 2 Bände.

With the establishment of the Institut für Schiffs- und Tropenkrankheiten at Hamburg in 1900, he was called to take charge of the division of tropical medicine and concomitantly to become ausserordentlicher Professor of Tropical Medicine in the university. From the opening of the Institut in 1901 until 1910 he served as military physician and later held other official medical appointments. In addition to his duties as a physician he conducted an extensive research program and taught in the medical school of the university. Entirely familiar with his subject by first-hand observation and investigation, enthusiastic in the prosecution of his work, endowed with a forceful and gracious personality, he became widely known as a brilliant and inspiring teacher. To supplement regular laboratory instruction, he assembled demonstration ma-

terial from all parts of the world and built up a great museum of tropical medicine. He was a congenial colleague, a loyal and trusted friend of Professor Dr. Bernhard Nocht, the founder and first director of the Institut. On the retirement of Prof. Nocht in 1930, Fülleborn was elected his successor, a fitting recognition of thirty years of distinguished service. Indeed, among students of tropical medicine throughout the world he had long been regarded as the ablest and most original worker in Germany.

H. B. Ward, writing in the JOURNAL OF PARASITOLOGY, vol. 19, p. 150, stated that "the foundations of modern parasitology were laid broad and deep by Leuckart, recognized at home as *Altmeister der Helminthologie* and acknowledged as the great leader by students in all nations." According to Ward it was "the biological emphasis that made Leuckart's teaching and writing so stimulating." Although Leuckart died during Fülleborn's first expedition to Africa, the younger man adopted the biological approach and experimental methods of the "Altmeister" of Leipzig, and Professor Nocht in a recent article on "Das Institut für Schiffs- und Tropenkrankheiten in Hamburg," declared that, "Die Schule Fülleborn ist eine der wenigen Stellen in Deutschland, in welcher zur Zeit noch Studien in der alten Leuckartischen Arbeitsrichtung betrieben werden." The Leuckart method is based on the conception of the parasite as a living organism carrying on its vital activities within the bodies of other living organisms. It is concerned with the bionomic interrelations between host and parasite, with the reproductive phases, dispersal stages, means of reinfection and pathological effects of the parasite. The method is essentially an experimental one, and Leuckart did not hesitate to test his hypotheses on himself and on his collaborators. Fülleborn was an ardent disciple of the cult, and an English reviewer once referred to his experiments as ceremonies in which he officiated both as high priest and as sacrificial lamb.

In order to further his knowledge by observation under natural conditions, he made repeated expeditions to study tropical diseases in their endemic centers. In 1906 he visited Egypt, East Africa, Ceylon and India. In 1908–1909 he led an expedition to the Bismarck Archipelago of the South Seas, the results of which have enriched not only the subject of tropical medicine but the ethnological collections of Hamburg and other cities. Investigations on the etiology and control of various diseases have led at one time and another to East Africa, South, Central, and North America, China, Japan, India, and the Balkan states. His early interest was in the pathology of tropical diseases but shifted gradually to the organisms which serve as causative agents. His researches covered a wide range of subjects, extending from the spirochaetes and spirochaetosis through the diseases caused by protozoans, insects, arach-

nids, linguatulids, trematodes, cestodes, and nematodes. Over one hundred published papers, covering the entire field of tropical medicine and parasitology, bear witness to a life of tireless and brilliant investigation. His most noteworthy researches were concerned with parasitic nematodes, and the studies on *Filaria, Ancylostoma, Strongyloides, Ascaris,* and *Onchocerca* stand as a series of classical contributions in tropical medicine. An attempt to list or evaluate his achievements would be out of place in this note. It is sufficient to recognize the breadth of experience, the fertility of ideas, the resourcefulness in technical procedure, and withal the joy in biological experiment that characterize his life and work. The soundness of his judgment is illustrated through the verification by Richardson (1930) of Fülleborn's earlier opinion that African East Coast fever is not due to *Theileria,* as previously believed, but to a filterable virus.

During the world war his researches were interrupted by service with troops. He was wounded at Mons on the west front and later served as hygienic adviser in the control of malaria in the Balkans. In this work he demonstrated that he was at the same time a theoretical biologist and a skillful practical physician.

In 1926, his sixtieth birthday was made the occasion of a celebration and the Archiv für Schiffs- und Tropenhygiene, which he had served as editor for many years, dedicated Number 9, pp. 355–628 of Volume 30 as a Festschrift to Fülleborn. Thirty research articles by thirty-three authors from all parts of the world are included in that testimonial. The personal tributes paid by Schüffner and others in connection with the Festschrift are eloquent and well deserved.

With Fülleborn science was international and his laboratory was always open to investigators. Students from all parts of the world received a gracious and cordial welcome, an expression of genuine friendliness that enhanced the prestige of German science and promoted international good-will. His interest, enthusiasm, and sound counsel were a stimulating influence to those who worked with him, and his courtesy, sincerity, honesty, and unselfishness endeared him to all who knew him. He was as ready to praise the commendable as to condemn the trivial, false, and superficial. His brilliant and sterling mental qualities were linked with a nobility of character that made him an outstanding figure both in scientific councils and at social functions. One saw him at his best in his home where his rich experience, intellectual equipment, and personal charm were delightful. A man of modest means, he lived simply and well. The world has suffered a great loss in his passing. His American friends unite in an expression of sympathy to his widow and other members of the bereaved family.

THE VALIDITY OF *TAENIA CONFUSA* WARD, 1896[1]

MARLOWE G. ANDERSON

In 1894 and 1895, Dr. H. B. Ward obtained through a Lincoln, Nebraska, physician, two specimens of tapeworms which were noticeably different in external appearance from the two previously known *Taeniae* of man, *Taenia saginata* and *Taenia solium*. In view of the generally peculiar appearance, the dissimilarity in internal structure, and the extremely modified head, Ward (1896) proposed the specific rank of the form, and the name *Taenia confusa*. A detailed study was made by Guyer (1898) and the morphology described as thoroughly as the material would permit.

Two other cases of *Taenia confusa* have been reported, one by Chandler (1920) and one by Faust (1929). From their specimens Chandler and Faust added data on external and internal characteristics to that given by Ward and Guyer.

The specific characters of *Taenia confusa*, as described by Ward (1896, 1896a, 1897), Guyer (1898), Chandler (1920) and Faust (1929, 1930) are as follows: thin cuticula; delicate musculature; small calcareous bodies, somewhat fewer in number than in *Taenia saginata*; testes generally smaller than in *Taenia saginata*, though some as large or larger (Chandler); genital pore small and shallow, with a plug-like papilla nearly filling it; distinct receptaculum seminis preceded by a short, constricted thick-walled portion of the vagina, with cilia pointing towards the genital pore instead of away from it; shell gland oval; vaginal canal crossing shell gland, connected with uterus by separate canal opening into the dorsal side of the uterus; large, kidney-shaped ovaries; triangular vitellaria, wedged in between ovarian lobes; gravid proglottids very much elongated; gravid uterus with median stem and 14 to 18 irregularly arranged and irregularly ramifying lateral branches, with a series of finger-like branches transversely arranged across the anterior end, and the branches at the posterior end lying more obliquely to the long axis of the segment, giving the appearance of drooping in a "sort of plume-like shape"; eggs oval, 30–35 × 36–45 microns.

It is inevitable that doubt should arise as to the validity of the specific rank of a new species based on the data obtainable from four specimens which closely resemble a well-known species. In many respects *Taenia confusa* is similar to *Taenia saginata* and might well be only a variation of the latter. With this in mind, a comparative study of a large

[1] Contribution from the Department of Zoology, Northwestern University, Evanston, Illinois. The writer wishes to acknowledge the aid and criticism of Dr. F. D. Barker, under whose direction this work was done.

number of specimens of *Taenia saginata* has been made to determine the extent of variations which occur and whether or not the characters of *Taenia confusa* fall within this range, thus establishing the true taxonomic status and rank of *Taenia confusa.*

Parker and Haswell (Textbook of Zoology, volume 1, pp. 2–3) state,

> . . . the only criterion of a "good species" is usually the presence of constant differences from allied species. . . . If there are no intermediate gradations between two sets of individuals, they will be placed without hesitation in distinct species: if, on the other hand, there is a complete series of gradations between them they will be considered to form a single variable species.

A perusal of other definitions of species shows that this criterion is commonly accepted among zoologists for the determination of specific rank. It is at once apparent that a "good species" should be based upon a large enough number of specimens to prove the absence of intermediate forms between the new species and closely related established species. In the case at hand, *T. confusa* is at present based upon four specimens, the later of these to be reported showing considerable variation from the ones on which the species was originally based.

In this study, the entire collection of *T. saginata* in the possession of Dr. F. D. Barker was placed at the disposal of the writer. Of these, forty-one were used, the remaining being omitted because of a poor state of preservation of the material. The variations occurring in these specimens were studied, with particular reference to the characters which were described as being specifically different in *Taenia confusa.* Care was taken to avoid distortions due to handling of the material, those which showed appreciable amounts of shrinkage or other changes being discarded. The study was made from toto mounts and serial transverse and frontal sections of proglottids from each specimen.

Some of the variations found in gross characters are shown in the figures, and as will be pointed out, definite intergrading chains of variations are present. A summary of the variations found in all characteristics is given and compared with the standards for the species in question, in table 1. Inasmuch as the standards for *Taenia saginata* as described by Leuckart (1886) were used by Guyer in his comparisons, the same have been used here. Since the observations made in this study include greater extremes than the accepted limits described by Leuckart, the minima, maxima and modes are presented as additional data on these characteristics.

SCOLEX

The scolex was present on only two of the specimens used in this study, so that complete data on variation cannot be given with regard to this portion of the tapeworm.

Comparative Data on Taenia confusa and Taenia saginata

Characters	*T. confusa* (Guyer – *G.* Chandler – *C.* Faust – *F.*)	*T. saginata* (Leuckart)	*T. saginata*, based on this study.			
			Minimum	Maximum	Mode	% Mode
Cuticula*	0.0045	0.0105	0.0020	0.0205	0.0082	29%
Musculature	Delicate	Powerful	Delicate	Powerful	Heavy	34%
Longitudinal Muscles	Continuous	Not continuous	Not continuous	Continuous	Continuous	58%
Calcareous bodies						
(a) Number	Sparse	Numerous	Sparse	Numerous	Numerous	63%
(b) Size*	Up to 0.011	Up to 0.018	0.0082	0.0246	0.0123	52.6%
Seminal vesicle	Present	Absent	Absent	Present	Absent	72.5%
Diameter of Testes*	0.089–0.096	0.15	0.049	0.152	(0.06–0.08)	30.7%
Diameter of Vas deferens*	0.045	0.025 (0.04)	0.0143	0.049	0.024	29.2%
Length of Cirrus pouch*	0.31	0.5 – 0.5	0.102	0.620	(0.3–0.4)	45.7%
Depth Genital cloaca*	*G.* 0.05–0.08 *C.* 0.25	0.22	0.049	0.439	(0.1–0.2)	45.9%
Plug in Genital cloaca	Present	Absent	Absent	Present	Present	56%
Width Genital pore*	*G.* 0.45–0.6 *C.* 0.8 –1.2	Up to 1	0.028	0.7	(0.028–0.1)	33%
Receptaculum seminis						
(a) Length*	0.135	0.1	0.056	0.316	(0.1–0.2)	50%
(b) Thickness*	0.078	0.07	0.032	0.238	(0.032–0.05)	26%
Vagina	*G.* Doubtful *C.* Ciliated	Ciliated	Doubtful	Ciliated	Ciliated	95%
Posterior part of vagina	Modified	Modified	Not modified	Modified	Not modified	56%
Ovary	Kidney-shape	Round	Elongated laterally	Kidney-shape	Round	48.7%
Connection of Uterus with Shell Gland	Indirect	Direct	Indirect	Direct	Direct	74%
Vitellaria	Triangular	Rectangular	Triangular	Rectangular	Rectangular	68%
Scolex	*C.* Very much like *T. saginata* small, rectangular. *F.* Oval, 1.5mm. wide, 1.0mm. long, 1.2mm. thick. "Marginal elytra" present.	Very variable in size and shape. Up to 2mm. wide, 1.5mm. thick, 2mm. long.				
Eggs						
(a) Size*	*G.* 0.039 × 0.03 *C.* 0.042 × 0.033 *F.* 0.031 – 0.035 × 0.036 – 0.045	0.02 – 0.03 × 0.03 – 0.04				
(b) Pyriform apparatus	*G.* Absent *F.* & *C.* Present	Present				
Cysticercus						
(a) Host	Cattle (*F*)	Cattle				
(b) Size*	4 – 6 × 3 – 4	4 – 8				

* All measurements given in millimeters.

Ward (1897) described in detail a scolex supposedly that of one of his two specimens, and attributed important taxonomic significance to its characters, as indicated by the following statement (Ward, 1897:-182), "The most striking peculiarity of the new species is by all odds the head." Dr. C. W. Stiles examined this scolex and, according to Ward (1897a:321), stated that it could be "nothing else than the head of a *Dipylidium.*" As suggested by Faust (1930:905), "In one of the Nebraska specimens, carelessness of a technician apparently caused the loss of the original scolex." Accordingly, in the complete description of *Taenia confusa,* this scolex was not regarded as the head of the new form.

The scolex described by Chandler differed from that of a typical *T. saginata* only slightly in shape and size (Fig. 1). Such differences can be readily accounted for on the basis of contraction of the specimen, as observed by Leuckart (Figs. 2 & 3). One of the scolices in my possession (Fig. 4) was killed in a somewhat contracted condition and presents much the same appearance as shown by Chandler. This head was attached to a chain of proglottids which was in every respect typical of *T. saginata.*

The scolex of Faust's specimen (Fig. 5) is characterized primarily by the "delicate marginal elytra" in the cervical region. Similar structures are present on one of the specimens in my possession (Fig. 6). In comparing the drawings, these structures appear considerably narrower on the specimen of this study than on Faust's specimen. Faust, however, made his drawing from the living specimen, and personally stated to the writer that the elytra were difficult to see in the fixed specimen. The specimen used for Figure 6 had been killed and fixed before it came into the possession of the writer, and though the cuticular expansions in the cervical region are narrow, they are not difficult to see. In other respects the tapeworm bearing the scolex is a typical *T. saginata.*

EXTERNAL STRUCTURE

According to the descriptions of *T. confusa* the outstanding external difference from *T. saginata* is in the ratio between the length and breadth of the proglottids, *T. confusa* presenting a more elongated condition than is typical for *T. saginata.* In this study, a number of specimens were observed, however, in which different types of proglottids as to this ratio were present within the same portion of the chain (Fig. 7). This indicates, rather strikingly, that variations in this respect are entirely due to the state of contraction of the specimen at the time of fixation.

CUTICULA

A reference to the table will show that the range of measurements of the thickness of the cuticula extends from one much thinner than that

described for *T. confusa,* to one considerably thicker than that given for *T. saginata,* and that the mode is between the two standards.

MUSCULATURE

Guyer described the musculature of *T. confusa* as being much less powerful than in *T. saginata,* and noted also that in his specimens the longitudinal fibers extended from one proglottid to the next, while, according to Leuckart, the fibers terminate at the end of the proglottid in *T. saginata.* In this study, a very great amount of variation and intergradation in the condition of the general musculature was found. It was also found that the continuous condition of the longitudinal muscle fibers between the proglottids is more common than the discontinuous type, but enough of the latter were noted to show clearly that such a character cannot be used as a specific difference.

CALCAREOUS BODIES

Considerable variation was noted in the size and occurrence of the calcareous bodies, which, according to Guyer, are less numerous and smaller in size in *T. confusa* than in *T. saginata.* In this study, the mode was found to be nearer the condition described for *T. confusa* than that for *T. saginata.* Furthermore, there was no apparent correlation between the variations in this characteristic and those in other characteristics. For example, three specimens which exhibited the laterally elongated, the round and the kidney-shaped ovary, respectively, all had numerous calcareous bodies measuring 0.0123 mm. in diameter.

MALE SYSTEM

Testes. The testes of *T. confusa* are described as somewhat smaller than those of *T. saginata.* In this study, the variation covered a greater range than any previously described, and included both sets of standards. The mode was smaller than the sizes given for either *T. saginata* or *T. confusa.*

Vasa deferentia. The range of variation in the diameter of the vasa deferentia includes both of the species in question, and there is little correlation between this variation and that of other characters.

Vesicula seminalis. The seminal vesicle is a slight enlargement of the vas deferens after it has straightened out upon entering the cirrus pouch. This structure is supposedly absent in *T. saginata,* but present in *T. confusa.* The observations here show that it is absent in 29 cases and present in 11 cases. Its presence in a number of specimens which are in other general respects typically like *T. saginata* throws considerable doubt upon the specific character of this detail.

Cirrus and cirrus pouch. The cirrus is not, according to the descriptions, essentially different in the two forms under discussion here.

The variations in the length of the cirrus pouch extend from a minimum much shorter than that of *T. confusa,* to a maximum somewhat longer than that of *T. saginata.* The variations are quite regularly distributed over the range, allowing little possibility of a definite demarcation between the condition in the two species under discussion.

Genital pore. Guyer's discussion of the genital pore is as follows (1898:479):

> The genital pore, or generative cloaca as it is sometimes called, is very different in structure from that of either *T. saginata* or *solium.* The pore in the majority of cases is distinct but not prominent, and measures in the sexually mature proglottids about 0.45 mm. in diameter by only 0.05 to 0.08 mm. deep. *This extreme shallowness is almost sufficient in itself to exclude this form from belonging to the above named species*;[2] for example, *T. saginata,* according to Leuckart, has a wide pore or a funnel-like cavity, 0.22 mm. deep. The pore in *T. confusa* contains a large plug-like projection at the outer extremity of which the seminal duct opens. This plug is so large in fact that the cloaca is almost obliterated, being only a slight depression left between the edge of the plug and the lip of the pore, due to the rounding off at the end of the former. It generally extends out even with the edge of the proglottid and sometimes a trifle beyond. As mentioned above, the cirrus opens out about its center and when not protruded there is a slight invagination or pit at the end of the plug.

The depth of the genital pores of the specimens used in this study ranged from 0.049 to 0.439 mm., the mode falling in the range 0.1–0.2 mm., with an incidence of 45.9 per cent. While the upper extreme of the mode is near the condition supposedly normal for *T. saginata,* the lower extreme is equally near the normal for *T. confusa,* and the distribution within this class as well as below and above it is closely enough intergraded to leave no doubt that this character is decidedly not "almost sufficient in itself to exclude this form from belonging to the above named species."

With regard to the plug-like projection, a study of the drawings (Figs. 8–17) is convincing of the presence of intergradation in this structure. The presence of such a plug (though small in several cases) was noted in 56 per cent of the specimens studied. In a few cases the plug was found to be present in some proglottids, absent in others—almost positive evidence that this structure is a result of the condition of the individual proglottid at the time of fixation. That such changes may occur, and have been previously noted is borne out by Leuckart (1886:441), ". . . the generative cloaca is able to undergo manifold changes in form and width, and thus to narrow or widen its opening. These changes occur mainly in consequence of the pressure and traction of the adjacent body muscles."

FEMALE SYSTEM

Vagina. In his study of *T. confusa,* Guyer was not certain that cilia were present in the vagina, and was inclined to interpret them as tiny

[2] The italics are my own.

folds in the wall, with cilia, if present, pointing toward the genital pore instead of away from it as is ordinarily (Leuckart) the case in *T. saginata.* Chandler (1920:36), however, found distinct cilia pointing toward the pore. In this study it was found that the cilia pointed toward the pore as often as away from it. In two of the specimens used, the presence of cilia in the vagina was doubted. In these two cases, like Guyer's, the wall of the vagina seemed to be thrown into tiny folds. It seems quite likely that this condition is due to the condition of the material or to the fixation.

Receptaculum seminis. Guyer describes a peculiar modified structure in connection with the seminal receptacle. Shortly before reaching the receptacle, the vagina becomes slightly enlarged and then abruptly narrowed, the narrower portion presenting a strikingly different structure, and projecting forward into the slight swelling of the vagina. This constricted portion of the vagina continues back to the receptaculum. Guyer further states that although Leuckart pictures such a modification in *T. saginata* (1886:444), he has found no such structure in his own preparations of *T. saginata,* but it is distinctly present in *T. confusa,* and he lists this as a difference in his table of comparative data on the two species. In this study, the modification does not appear in the majority of cases (58 per cent), it is distinctly present in 13 cases, and a slight modification was observed in 5 cases. In these "slightly modified" cases, the enlargement and abrupt narrowing of the vagina was noted, but the extreme modification of the walls in this region was not apparent. Thus these cases appear to represent intermediate stages in this characteristic.

Shell gland. With respect to the shell gland and its associated ducts, the only difference in the structures between *T. confusa* and *T. saginata* is in the canal which bears the fertilized eggs to the uterus. Guyer states, "unlike the case in *T. saginata* and *T. solium,* this canal does not enter the posterior end of the uterus, but extends along above it for some distance, gradually declining until it finally enters the dorsal side of the same." In this study both the direct and the indirect connections were observed, the direct being the most frequent (74 per cent). The indirect connection is not limited in occurrence together with any other particular characteristic, and therefore cannot be called a specific character.

Ovary. In toto mounts of mature proglottids, the ovary, together with the vitellaria are the outstanding characteristics on which a diagnosis between *T. confusa* and *T. saginata* is based. In the typical *T. saginata,* the lobes of the ovary are round in shape, the one on the side in which the vagina passes to the genital pore usually being smaller than its mate. In *T. confusa,* according to Guyer, the lobes are greatly elongated (Fig. 26) or kidney-shaped, the elongation being anterio-posteriorly. In Chandler's specimen (Fig. 24) the elongation of the ovarian lobes is not so pronounced.

A study of the figures (Figs. 18–28) shows clearly the range and intergradation of variations found in this study. A series, from the opposite extreme of variation, that is, elongated laterally (Fig. 18), to an even greater elongation (Fig. 28) than that depicted by Guyer is shown. The fact that both types may be found in a single specimen (Fig. 7) is further evidence that this character is not diagnostic nor specific.

A definite correlation between the shape of the ovaries and the state of contraction or extension of the specimen when fixed may be shown. This correlation is indicated by the outlines of the proglottids in the figures showing the variations in the ovary. Those specimens which were killed much contracted or shortened always show the laterally elongated ovary, those killed extended show the anterio-posterior elongation or kidney-shape. Not a single case was found where this correlation did not hold. The figure showing three proglottids from the same specimen (Fig. 7) shows this correlation within different parts of the same individual.

Vitellarium. The typical appearance of the vitellarium in *T. saginata* is rather rectangular, being only slightly if at all wedged in between the ovarian lobes. In *T. confusa,* according to Guyer, it is triangular in shape, wedging in between the lobes, and tapering off to the shell gland. The variations observed in this study are indicated in the same series of drawings as referred to with regard to the ovary. It will again be noted that a definite series can be traced, and that a correlation between the condition of the vitellarium and the state of contraction or expansion of the proglottid exists.

Uterus. With regard to the uterus, Guyer states (1898:484), "It has an exceptional structure which defeats beyond all doubts any attempt to classify its possessor as one of the common forms of *Taenia.*" The first difference mentioned is that of the connection between the uterus and shell gland as previously discussed. It has already been shown that this detail is not specific.

In the unmodified form of the uterus in mature proglottids, there is no difference other than the connection mentioned above, between the two forms. In the gravid proglottids of the typical *T. saginata,* the uterus consists of the main stem with from 20 to 30 lateral branches which extend, usually perpendicular to the main stem. According to Guyer, the uterus of *T. confusa* consists of the main stem with from 14 to 18 branches on each side which are irregularly disposed throughout the parenchyma and rarely extend perpendicular to the main stem. They break up very soon into two or three branches which may again divide in a similar way. The branches at the anterior, and especially at the posterior ends of the proglottids are longer and lie more obliquely to the long axis of the segment. The posterior ones have the appearance of drooping in a "sort of plume-like shape."

In this study a great range of variation in the gravid uterus has been noted. The variation is particularly evident in regard to the course of the branches and the appearance of the branches at the ends of the proglottids. The "drooping in a sort of plume-like shape," supposedly characteristic of *T. confusa* (Fig. 33), was found in more of the cases studied than the type with the branches running perpendicular to the main stem. That a series between these two types can be shown is made evident by the figures (Figs. 29–34). Even in cases where the majority of the branches extend perpendicular to the main stem, the terminal branches tend to the oblique course (Fig. 30). As in the case of variations in the shape of the ovary and vitellarium, both types were frequently found occurring in the same specimen, with a definite correlation between the extension or contraction of the individual proglottids and the appearance of the uterus. Thus a proglottid killed in an extended condition shows the "drooping" of the end branches, while those less extended show this characteristic to a lesser degree.

As to the number of uterine branches, observations show the range to be from 14 to 30 main branches on a single side of the median stem. Uteri possessing numbers of branches falling in the lower part of the range, were observed in specimens in which the mature proglottids showed none of the other characteristics of *T. confusa*. It is apparent, therefore, that the number of uterine branches may be from 14 to 30 connecting with the main stem on each side. There was found to be no apparent correlation between the number of uterine branches and the general appearance of the gravid uterus.

Stephens (1908:549) described *Taenia bremneri* on the basis of the gravid proglottids of one incomplete specimen. The differentiating diagnostic characters are the size of the proglottids and the number of uterine branches.

It has been previously suggested that these are very much relaxed proglottids of *T. saginata*. Chandler (1920:35) regards them as proglottids of *T. confusa*.

In this study no proglottids were found which measured up to the maximum size (32 mm. × 9 mm.) given by Stephens for *T. bremneri*, but several were found which measured 29 mm. × 10 mm., the most common size for *T. bremneri* as given by Stephens. In Chandler's specimen of *T. confusa* gravid proglottids were found which measured 33 mm. × 8 mm. These together with those found in this study may well constitute an intergrading series between *Taenia saginata* and *Taenia bremneri*. The number of uterine branches (22–24) given for *T. bremneri* falls within the range for *T. saginata*. These data clearly indicate that *T. bremneri* should be considered a synonym of *T. confusa* and *T. saginata*.

EGGS

A detailed study of the eggs was not made. No striking difference between the two forms under discussion has been noted in this respect. The size of the eggs, as given by Guyer, falls within the range of sizes for *T. saginata* (see table). The maximum sizes given by Chandler and by Faust are only slightly above the standards, and they fall, for the most part within the range. Guyer stated that the pyriform apparatus was apparently absent, or not conspicuous, but Chandler and Faust state that in their specimens it was conspicuous.

CYSTICERCUS

There remains only the life cycle to be considered. Unfortunately sufficient material was not available for an adequate study of variations in cysticerci in this study. Considerable variation in size, however, has been noted.

The only data on the life cycle of *T. confusa* is the work of Faust (1929, 1930). He used eggs from the specimen in his possession and produced an infection of cysticerci in a suckling calf, but no infection resulted from experiments with a rabbit. Experiments were apparently not attempted with other animals. Faust thus considered the intermediate host of *T. confusa* as beef—*the same as for T. saginata.* He states that the cysts were somewhat smaller than those of *T. saginata,* but also notes that these cysts were not fully developed at the time the calf was killed.

Faust's data do not offer any evidence for considering *T. confusa* as a valid species from the standpoint of the life cycle. On the contrary, an identical intermediate host, together with the fact that the cysts differ only in respect to size (and these cysts not fully developed) support the evidence given in this study that the species *T. confusa* is identical with *T. saginata.*

CONCLUSIONS

It has been shown that in a study of a large number of specimens of *T. saginata,* variations occur which extend the ranges of variation of this species to include all of the characteristics which have been described as specific for *T. confusa.* Complete series of intergrading forms have been shown to exist, as well as the occurrence of various supposedly specific *T. confusa* characteristics in specimens which were in all other respects typically *T. saginata.*

From the definition of a species, it is evident that two such intergrading forms cannot exist as separate species. Aside from the academic point of definition, there must be a definite demarcation between species for practical purposes, and the data reported here show that there is no

basis on which such a separation of *T. saginata* and *T. confusa* can be definitely made.

It is therefore concluded that the species of human tapeworms designated as *Taenia confusa* Ward, and *Taenia bremneri* Stephens, are variations of the species *Taenia saginata* Göze, and the identity of these species is herewith established.

SUMMARY

1. It has been shown that in every detail described as being specifically different in the tapeworms of man, *Taenia confusa* Ward and *Taenia saginata* Göze, there is an intergradation of variations between the two forms. According to the accepted definitions of a species, as well as from a practical standpoint, there can be no such series of variations between forms which are distinct species.

2. Further lack of sufficient basis for a separation of these species is proven by the existence of single individuals which possess, in their various proglottids, characters designated as specific for each of the two forms.

3. From these data, one is forced to the conclusion that *Taenia confusa* is not a valid species, but represents a variation of, and is a synonym of *Taenia saginata.*

4. This study has made apparent new limits in various measurements and other characteristics of *Taenia saginata.* These details are presented, together with the summary of the detailed observations, in tabular form.

5. It is obvious that error may occur and confusion arise in creating a new species on the basis of a limited number of specimens. Such practice should be avoided, particularly in describing as a new species a form which is similar to a previously known species, without first having determined, through the study of a large number of specimens, the ranges in variations and the absence of intermediate forms.

References Cited

Chandler, A. C. 1920.—A new record of *T. confusa,* with additional notes on its morphology. Jour. Parasitol., 7:34–38.

Faust, E. C. 1929.—The life cycle of the rare human tapeworm, *Taenia confusa* Ward, 1896. Proc. Soc. Exp. Biol. & Med., 27:94–95.

1930.—A study of the rare human tapeworm, *Taenia confusa,* with a report of the fourth case. South. Med. Jour., 23:902–906.

Guyer, M. F. 1898.—On the structure of *Taenia confusa* Ward. Zool. Jahrb. Abt. f. Syst., 11:469–492.

Leuckart, R. 1886.—Die Parasiten des Menschen. (English translation by W. E. Hoyle.)

Stephens, J. W. W. 1908.—Two new human cestodes and a new linguatulid. Ann. Trop. Med. and Parasit., 1:549–556.

Ward, H. B. 1896.—Report of the Zoologist. Ann. Rep. Nebr. State Board Agri. for 1895, pp. 257–272.

1896a.—A new human tapeworm. Western Medical Review, 1:35–36. Also in Proc. Nebr. State Med. Soc. for 1896, pp. 83–87.
1897.—Report of the Zoologist. Ann. Rep. Nebr. State Board Agri. for 1896, pp. 173–189.
1897.—Note on *Taenia confusa*. Zool. Anz., 20:321–322.

Explanation of Plates

All figures were made with the aid of projection-tracings.

Key to abbreviations:

C. —Cirrus pouch.
Ut. —Uterus.
Ov. —Ovary.
S.G.—Shell gland.
V.G.—Vitellarium.

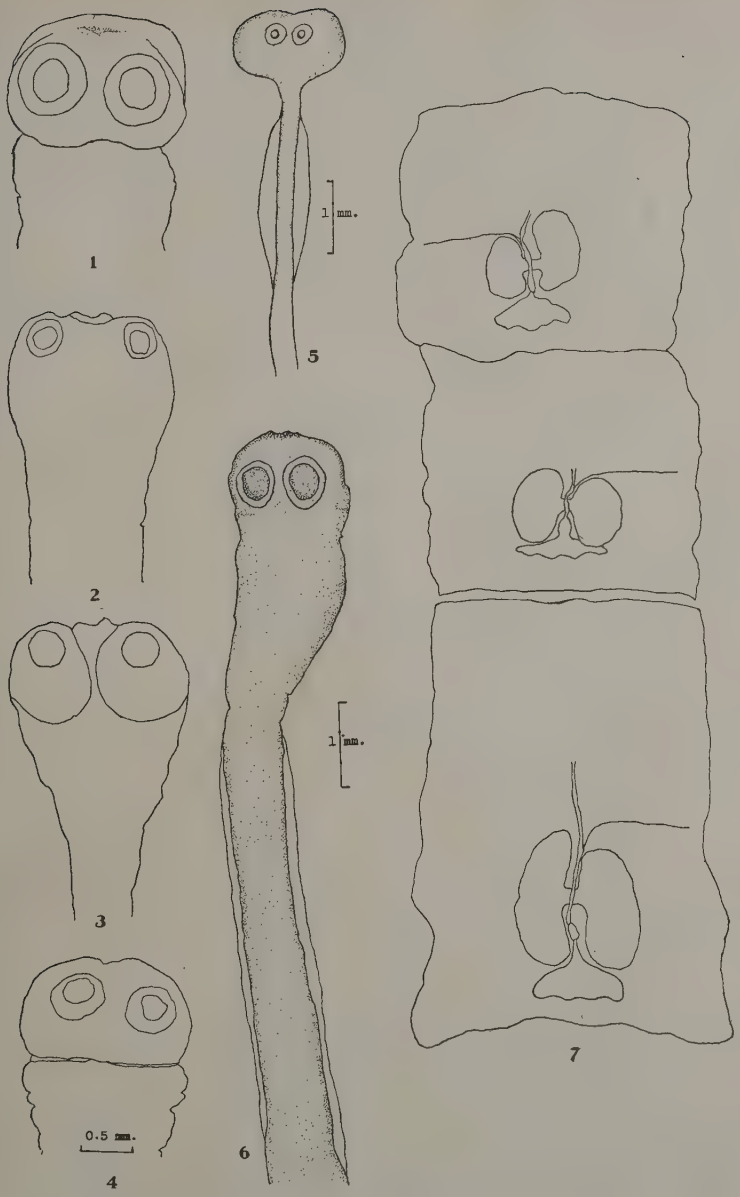
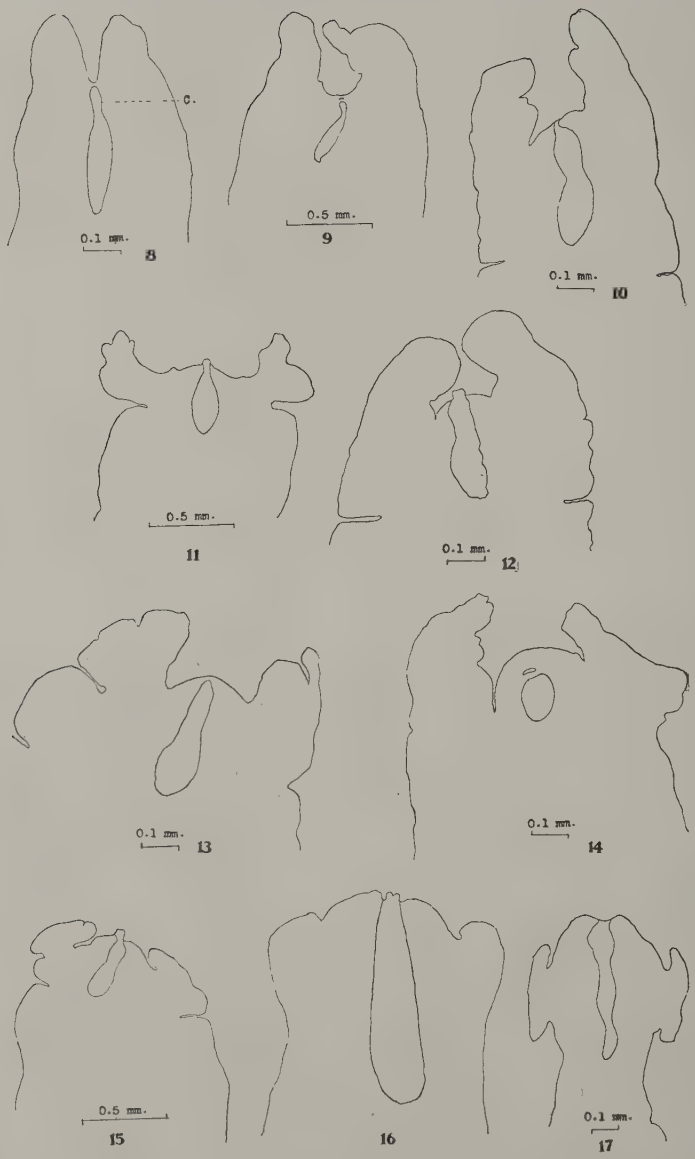
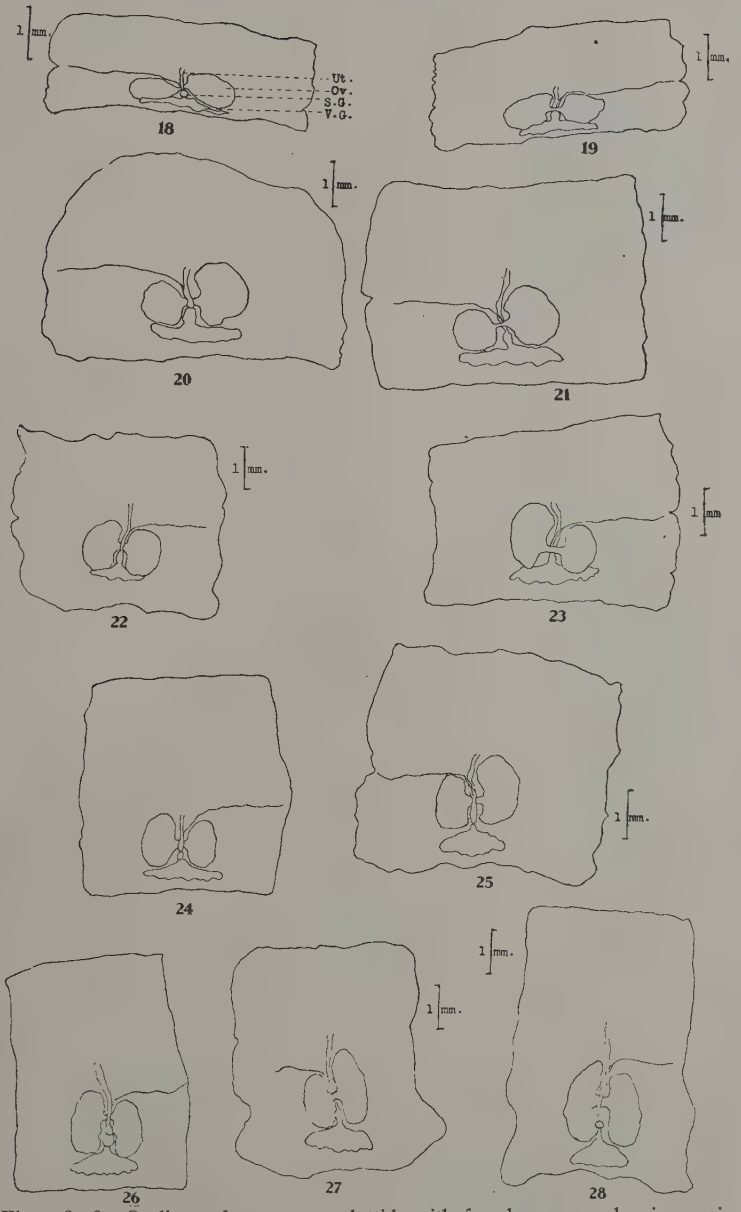


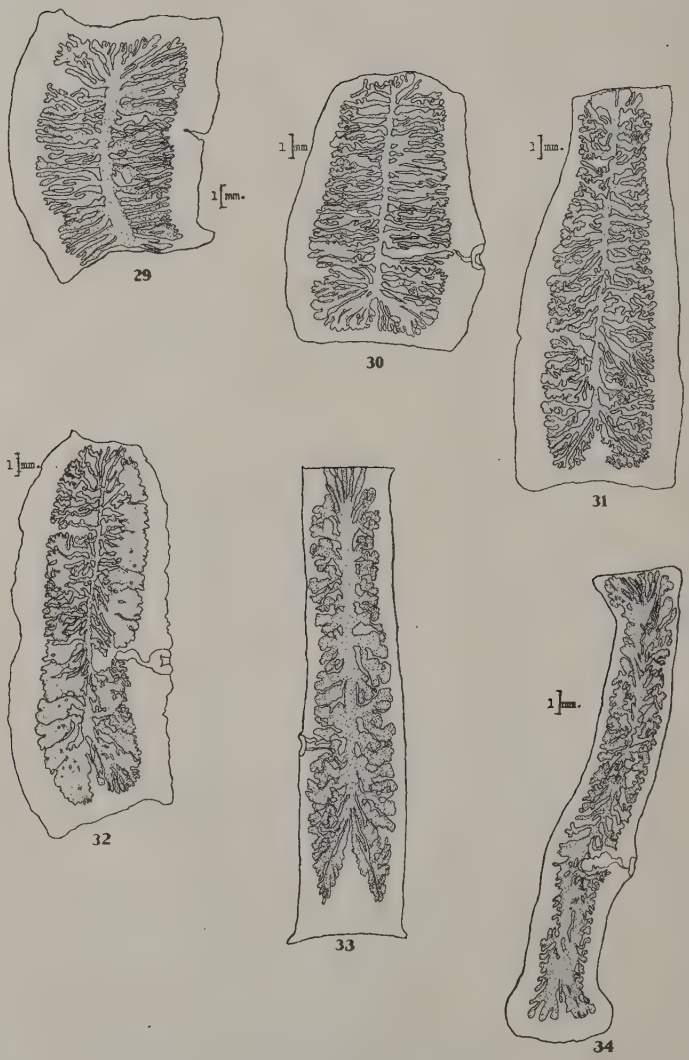
Fig. 1. Scolex of Chandler's specimen. (Outlined after Chandler.)
Figs. 2 & 3. Scolices of *T. saginata* in different stages of contraction. (After Leuckart.)
Fig. 4. Outline of scolex of *T. saginata* from this study.
Fig. 5. Scolex of Faust's specimen. (After Faust.)
Fig. 6. Scolex of *T. saginata* from this study showing "marginal elytra."
Fig. 7. Outline of three proglottids with female organs, from the same specimen of *T. saginata.*



Figs. 8–17. Outlines of cross-sections of mature proglottids through the genital pore, showing degrees of development of "plug." (Fig. 16 after Guyer.)



Figs. 18–28. Outlines of mature proglottids with female organs, showing variations in shape of ovaries and vitellaria. (Fig. 24 after Chandler, Fig. 26 after Guyer.)



Figs. 29–34. Gravid proglottids, showing variations in appearance of the uterus. (Fig. 33 after Guyer.)

PREVALENCE AND IMPORTANCE OF THE TROPICAL WARBLE FLY, *DERMATOBIA HOMINIS* LINN., IN PANAMA

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The tropical warble fly, *Dermatobia hominis* Linn., appears to be present in nearly all countries in the tropical and semi-tropical regions of the New World, and Panama is not exempt from this form of myiasis. Authentic reports that are available inform us that the attacks of the larvae of this fly on man in Panama have been recognized for at least seventy-eight years. If earlier records were available they would probably show that this fly has been known here for centuries.

Reports of various expeditions to the Darién Province of Panama searching for a feasible route for an interoceanic canal furnish us with information concerning *Dermatobia* in that part of the Republic. The "gusano de monte," as the larva of *D. hominis* is termed in Panama, was mentioned by Lieutenant Strain, in his report of the ill-fated expedition led by him in Darién in 1854, and is quoted by Sullivan (1) as follows:

> . . . he privately offered to load himself with provisions and accompany me through the forest until we had overtaken them, and this, too, although he had been expressly prohibited by Gisborne from attempting to cross the Isthmus, and was suffering severely from the gusano del monte, or wood worm, which had perforated his foot.

The report of the Isthmian Canal Commission Darién Survey, Eastern Division, 1899–1900, as presented by Hale (2) contains a paragraph by Dr. G. L. Wickes, surgeon to the expedition, in reference to the gusano as follows:

> Gusanos caused universal annoyance to all of the officers. They resembled boils very much, from which they were differentiated as follows: The gusano is caused by the larvae of some insect—probably the gadfly—hatching in the skin and forming a grub there. When squeezed the thin yellowish fluid always escapes from the apex of the tumor through a small aperture, which is constantly present. This is characteristic of the gusano. The grub is best expressed by squeezing, after the application of an impervious dressing.

A very interesting account of cases of myiasis in man caused by the larvae of *Dermatobia* is given by Adams (3), who writes as follows:

> In March, 1900, I was physician in charge of a party of seven whites and twenty-five natives, then exploring for a canal site at Caledonia Harbor, Isthmus of Darién. Of the seven whites, six became hosts of the parasites, and had a total of nineteen lesions. One white man who never took off his clothing escaped. Another, equally opposed to removing his clothing, had one parasite in his ankle, which he constantly exposed to the attacks of the fly by going around in slippers

and pajamas. Of the five remaining whites, all had at least two parasites, the writer having five. Among the natives, no record was kept as to the number of lesions, but it was noticed that, although they were in no sense immune from attacks from the parasites, they were seldom the hosts of more than one or two of the larvae at the same time. The white members of the party were first exposed to the attacks of the parasites March 14, 1900, several complained of small boils, which later proved to be parasitic. The locations of the parasitic tumors in the whites were as follows: ankle 4, elbow 2, abdomen 3, thigh 2, calf 2, upper arm 2, buttocks 1, back 3.

The frequency of infestation of man with the warbles, or larvae of *Dermatobia,* would seem to be about the same at the present day as in the past as shown by the foregoing quotations. Cases of cutaneous myiasis due to these larvae are of frequent occurrence throughout many parts of the Republic of Panama and the Canal Zone. Any party of individuals that spends much time in the low, humid, coastal or forest regions of Panama is quite likely to have some members infested with the larvae after a few days. There is no way of forming an estimate of the number of cases that occur among the natives living in the country districts. They customarily apply their own methods for extracting the larvae and usually with successful results. The cases that are commonly brought to one's attention are those that occur among the inhabitants of the Canal Zone and the cities of Panama and Colon that apply to the hospitals or dispensaries for surgical aid in removing the larvae.

An extremely remarkable instance of an invasion of the human brain by a larva of *Dermatobia* took place in a case of myiasis with fatal termination that occurred in the Canal Zone in 1929. Since cases of cerebral myiasis are of very rare occurrence, they are well worth recording when they do occur. For the information concerning this case I am indebted to Drs. R. O. Dart and L. B. Bates (4), Pathologist and Director, respectively, of the Board of Health Laboratory, Ancon, C. Z., for their kindness in supplying me with a copy of the Clinical Record and Autopsy Protocol with permission to include data from these records in this paper. The patient was a black, female child, one and a half years of age. She was admitted to Gorgas Hospital, Ancon, C. Z., on June 1, 1929. Chills and fever had begun five days previous to admittance. Parasites of both tertian and estivoautumnal malaria were found in her blood and quinine treatment was given. On June 10th the child was about to be discharged when it was noticed that pustules were present in her scalp and she was retained for treatment. Five days later larvae were removed from the pustules on the scalp and also on her back. On June 25th new pustules were found on the child's head and she was taken to the operating room for removal of the larvae. An eruption then developed and on June 27th the child was transferred to isolation with a diagnosis of measles. Convulsions occurred and the child died on July 2nd. The autopsy was performed by Dr. R. O. Dart and all pathological

findings in relation to it are from his record. A few notes pertaining to the salient lesions caused by the dipterous parasite in this case have been abstracted from the autopsy protocol and are as follows:

Scalp: "There is a small round hole through the scalp over the middle of the anterior fontanel of the skull."

Skull: "The anterior fontanel is perforated through the fibrous portion in its middle by a small round opening about 4 mm. in diameter."

Meninges: "Beneath the opening in the fontanel and slightly to the left of the longitudinal sinus is a small perforation in both the dura and pia-arachnoid."

Brain: "The external appearance of the right hemisphere is normal. The upper and anterior portion of the left is collapsed and thin around the opening. This opening communicates with a cavity approximately 4×6 cm. which opens into the left lateral ventricle. Lying against the external wall of this cavity is a large larva which resembles that of *Dermatobia cyaniventris*." The cause of death as found at autopsy on this case was "Myiasis of the scalp and brain (145g)."

It may be mentioned here that *D. hominis* and *D. cyaniventris* are considered as synonymous.

That clothing does not furnish the protection against infestation that one would naturally suppose, is evident from my own experience and also from other cases observed in Panama. In my case I had the opportunity of seeing a fly in flight carrying eggs with mature larvae and I was able to capture this special messenger selected by the female *Dermatobia* to deliver her progeny to hosts. As reported in an earlier paper (5) this carrier fly, *Limnophora* sp., was captured after it had been observed hovering about me and alighting several times on my right knee. My attention was attracted to this fly by a white substance that seemed to be attached to it. This was found to consist of a number of eggs of *Dermatobia hominis* that were attached in overlapping rows to the abdomen of the fly. Many of these eggs had developed to the larval stage with the anterior end of each minute larva protruding from the shell and actively wriggling while the posterior end remained in the shell. Although I was wearing khaki drill breeches and leather puttees at this time, I discovered two larvae in the skin of my right leg two days later. One of these was located in the inner surface of my right thigh, about midway between the knee and perineum, and the other was in my shin just below the knee. It is quite certain that these two larvae had penetrated the drill breeches to reach my skin.

The locations of the warbles noted in man would not indicate a marked preference for any part of the body. The skin on any part of the body from the eyelids to the middle of the back seems to provide a suitable situation for the larvae. They may occur in sites that would habitually be covered with clothing about as frequently as in parts that are usually exposed. In children they seem to occur about the head and neck somewhat more frequently than in other parts of the body.

The following abstracts from the Annual Reports of the Governor of the Panama Canal, in reference to the loss sustained by the Division of Cattle Industry—conducted by the Supply Department of the Canal —due to the *Dermatobia,* well demonstrate the importance of this fly from a purely economic standpoint.

The Report for 1928 (6) contains the following statement:

> The gross revenue for the sale of cattle during the fiscal year amounted to $391,322.14 and the cost of sales was $456,878.60, resulting in a loss of $65,556.46, as compared with a loss of $16,254.85 during the preceding year, an increase in deficit of $49,301.61. This increase in deficit is due primarily to the introduction of a grub known as *"Dermatobia hominis"* through the importation of Venezuelan cattle. This grub killed 900 head and rendered approximately 3,000 more unfit for slaughter. The same grub was brought into the Zone pastures once before by the importation of cattle from Nicaragua. The results then were much less serious and the grub disappeared during the following year. If the climate on the Isthmus were suitable for its development it would have been established here for years.

The Report for 1929 has the following to state in relation to *Dermatobia*:

> The operation of the cattle industry continued as before, except for some curtailment. At the beginning of the fiscal year 4,358 head of stock were in the pastures. During the year 6,176 head were purchased and 3 calves were born. There were 398 deaths from various causes, 51 transfers, and 8,666 head were slaughtered, leaving on hand in the pastures at the close of the year 1,422 head of stock. The loss of 398 head by death was due mainly to the grub, *Dermatobia hominis,* which during the preceding year had killed 900 head and rendered approximately 3,000 more unfit for slaughter. This grub was not so prevalent during the past fiscal year, due to the energetic measures undertaken to bring about some degree of control. To this end and in an effort to eliminate the pest reclearing and burning of pastures were carried on from November to June, some 7,500 acres of pasture land being burned over. The total expended for clearing and burning pastures was slightly in excess of $8,000 or a net cost of about $1.08 per acre. The gross revenue from the sale of cattle during the fiscal year amounted to $546,685.09 and the cost of operations was $550,027.68, resulting in a loss of $3,-342.59 as compared with a loss of $65,556.46 during the preceding year.

The Report for 1930 (8) is as follows:

> At the beginning of the fiscal year the cattle in pastures amounted to 1,422 head. Owing to the ravages of the grub known as *Dermatobia hominis,* which had caused most of the 398 deaths among the cattle in the previous year and in the fiscal year 1928 killed 900 head and rendered approximately 3,000 more unfit for slaughter, use of the pastures was abandoned to a large extent and the practice adopted of purchasing fat cattle for slaughter shortly after delivery. During the past year 1,979 head of fat cattle purchased in Cuba and 5,949 purchased in Panama were delivered and slaughtered. Including the foregoing and 314 steers, 86 cows, and 1 bull from the pastures, sales to the commissary division amounted to 8,329 head. Seventy head of lean cattle were purchased and placed in Canal Zone pastures for the purpose of determining the status of the *Dermatobia hominis.* Stock on hand on June 30, 1930, was 248 fat steers, 80 feeders, and 28 breeders—a total of 356 head.

From the foregoing abstracts it may be noted that the *Dermatobia* not only caused the death of a considerable number of cattle in the Canal Zone herds during the period from 1927 to 1930, but also occasioned a change in the method of conducting the Cattle Industry. Where previously lean cattle had been purchased and allowed to fatten in the Zone pastures, it later became necessary to buy only fat cattle that could be slaughtered soon after they were received. This eliminated their being pastured on the Zone except for a short period of time. The detriment caused by the fly was instrumental in reducing the number of cattle in the pastures from 5,908 on July 1, 1927, to 356 on June 30, 1930. It has also resulted in thousands of acres of land remaining unoccupied that were cleared, fenced and planted with rich grasses for pastures.

It may be difficult for any one not familiar with the exact conditions to understand why the death of so many cattle should be caused by infection with the larvae of *Dermatobia*. It was only necessary, however, to observe the number of larvae with which the cattle were infested to realize the facts. Through the kindness of Mr. J. H. K. Humphrey, Assistant Chief Quartermaster of the Panama Canal, I was afforded frequent opportunities to observe the conditions existing in this herd of cattle. Some of these animals had thousands of the warbles in their skin. Not infrequently an animal could be seen that was literally covered with warbles from its face back to the tail and from the back down to the knees. Masses of the warbles crowded together so closely that they formed extensive swollen areas in many of the animals. Large nodular swellings containing a considerable amount of pus were also common. It was hard to believe that cattle could become so badly infested. Some showed a much heavier infestation than others. Possibly some of them may have acquired a certain amount of immunity against the larvae. Many of the animals showed the effects of the warbles by their thin and emaciated condition although for months they had been in pastures where good grass was to be had in abundance.

The seventy head of lean cattle that were purchased by the Cattle Industry in 1930 for the purpose of determining the prevalence of *Dermatobia* in certain of the pastures furnished an excellent opportunity for me to observe the rapidity with which these animals became infested. These cattle were purchased in Chitre, R. de P., and shipped to Panama City by boat. They were lean three-year old steers and were clean and healthy looking. Upon their arrival at Panama they were examined closely and no warbles were detected in them. On February 20th, 1930, the day following their arrival at Panama City, they were placed in a pasture at Summit, in which no cattle had been present for more than a year and which had also been burnt over during this interval.

On March 14th these steers were rounded up and placed in a corral

for inspection and I was able to examine them after three weeks in the pasture. Many of them were at this time found to be infested with numerous larvae. Several of these larvae were squeezed out and some were found to be sufficiently large to indicate that the cattle must have become infested soon after being placed in the pasture. On March 29th I again inspected these young steers and many of them were found to be very heavily infested. One of them that was roped and tied for close examination was found to have a number of empty warble pockets. Mature larvae had emerged from these pockets. Many fully mature larvae were also found in this animal as well as in several others from which specimens were removed. This would indicate that the larvae may mature in cattle in less than thirty-seven days.

The larvae seemed to exert a much more damaging effect on these young steers than on older animals. Many of the warbles were unusually large and appeared as large lumps or tumor-like swellings. Some of these when squeezed spurted out pus and bloodstained serum. A number of these swellings were located in the legs of the animals and were so prominent that they gave the appearance of a leg deformity. Larvae were noted even in the eyelids of some of the steers.

The infestation in these cattle served well to demonstrate the abundance of *Dermatobia* and of the egg carriers that were present in the vicinity of these pastures. This experiment was conducted in a pasture that was situated more than a mile from the nearest occupied pasture. It had been idle more than a year and had been burnt over in addition since it was last used as a pasture. It showed the short period of time necessary for cattle to become heavily infested and the rapidity with which the larvae may mature in young cattle.

Dermatobia occurs in many parts of Panama, especially in the coastal plains and forested regions, and at times becomes very numerous in areas where cattle are raised. It seems, however, to vary greatly in its annual incidence. It seldom becomes so troublesome in other sections, however, as it did in the pastures of the Cattle Industry of the Canal Zone during this period of time. It would appear that these pastures presented optimum conditions, whatever they may be, for the development of this fly.

There are so few sheep in Panama that observations relating to their infestation with *Dermatobia* larvae have been limited. Nevertheless, it is known that they sometimes not only become heavily infested but also frequently develop severe abscesses with a considerable amount of pus present in the warbles.

Dogs are frequently hosts for large numbers of the larvae and apparently suffer considerably from them. An infested dog may have warbles in any part of its body from eyelids to scrotum. Some dogs have been seen with their feet so badly infested that they had great difficulty

in walking and could only hobble about. Hunting dogs affected in this manner are of no use for hunting purposes until the larvae are removed. Dogs have been noted licking and biting at warbles in their feet or other parts of the body that they could reach with their mouth but apparently they were unable to rid themselves of the larvae. Recently, a young police dog was examined for what the owner considered to be drooping ears. A number of larvae were found in each ear and others were located in a row in the skin along the median line of the back of the animal. Two of the larvae, about half grown, were located at the end of the left ear with the apertures of the warbles at the lower tip of the ear. That the dog was suffering considerable pain and annoyance from these larvae was evident from the manner in which it shook its head and pawed its ears. Five vagrant dogs were recently collected at a small village in the Chagres River valley and brought to this laboratory to be examined. Four of these were found to be infested. There were 8 in one, 4 in a second, 4 in a third and 1 in the fourth. These larvae ranged in size from a half-grown stage to nearly full maturity. There may have been many others concealed by the hair that were too small to be visible to ordinary inspection.

Three half-grown larvae were found in a vagrant cat that was recently examined and two good-sized larvae were removed from the neck of an old rabbit that had been allowed to run about in the laboratory yard.

Various wild animals are also subject to the attacks of the *Dermatobia* and they must undergo considerable pain and annoyance as a result of it. Of the numerous animals that have been received at this laboratory during the past three years, the monkeys and agoutis have been most commonly found to have warbles. The larvae have been found in the four following species of monkeys: The black howler (*Alouatta palliata inconsonans* Goldman), brown howler (*Alouatta palliata palliata* Gray), red spider (*Ateles geoffroyi* Kuhl) and the black spider (*Ateles dariensis* Goldman). Some of the larvae in these animals were large and about mature. This fact would lead one to conclude that nature has not yet taught the monkeys, of these four species at least, a method of removing the larvae after becoming infested.

A number of agoutis representing the three species, *Dasyprocta punctata isthmica* Alston, *D. p. muchalis* and *D. p. dariensis,* have been found infested. Larvae, nearly mature, were located in the skin of the snout, near the tip, in several of these infested animals. They occasioned large swellings and probably were quite painful to the agoutis.

SUMMARY

1. Records of early exploration in Panama inform us that *Dermatobia hominis* have been known in this Republic for many years.

2. Cases of myiasis produced by this fly are of frequent occurrence in man and cause considerable annoyance and irritation.

3. Cerebral myiasis produced by this fly recently occurred in a child in the Canal Zone with a fatal termination.

4. *D. hominis* affects cattle so extensively in some parts of Panama that it is of considerable importance from a purely economic standpoint. Its attacks on the cattle of the Division of Cattle Industry of The Panama Canal produced such serious results that practically all pasturage operations of the Industry have ceased for the time being and only fat cattle ready for very early slaughter are now purchased.

5. Besides man and cattle many other animals in Panama suffer from this fly. These include sheep, dogs, cats, rabbits, monkeys, agoutis, etc.

References

1. Sullivan, Lieutenant John T. 1883.—Report of historical and technical information relating to the problem of interoceanic communication by way of the American Isthmus. p. 60. Bureau of Navigation, Navy Department, Washington.
2. Hale, H. C. 1903.—Notes on Panama. p. 269. Washington.
3. Adams, J. Lee. 1904.—Tropical cutaneous myiasis in man. Jour. Amer. Med. Assoc., 42:947–949.
4. Dart, R. O., and Bates, L. B. 1929.—Autopsy Protocol No. 8680 of the Gorgas Hospital Series of Autopsies. Board of Health Laboratory, Gorgas Hospital, Ancon, Canal Zone.
5. Dunn, Lawrence H. 1930.—Rearing the larvae of *Dermatobia hominis* Linn. in man. Psyche, 37:327–342.
6. Annual Report of the Governor of The Panama Canal, 1928. p. 47. Washington.
7. Annual Report of the Governor of The Panama Canal, 1929. p. 54. Washington.
8. Annual Report of the Governor of The Panama Canal, 1930. pp. 58–59. Washington.

NOTES ON THE OCCURRENCE OF *GIGANTORHYNCHUS ECHINODISCUS* DIESING IN THE ANTEATER OF PANAMA

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The large, spineheaded worm, *Gigantorhynchus echinodiscus* Diesing, one of the Acanthocephala, seems to be quite common in Brazil but apparently is little known elsewhere. Travassos (1) has reported specimens of it having been taken from anteaters in that country, representing three genera: *Tamandua tetradactyla* (L.), *Myrmecophaga jubata* (L.) and *Cyclopes didactylus* (L.). Strong, Shattuck, Bequaert and Wheeler (2) while in Brazil as members of the Hamilton Rice Seventh Expedition to the Amazon also found this species in the duodenum and ileum of a *Tamandua tetradactyla.* Recently this parasite was encountered in Panama and a remarkable feature was noted in connection with its occurrence since specimens were spontaneously eliminated daily.

On March 28, 1932, an adult, female anteater, *Tamandua tetradactyla chiriquensis* Allen, weighing ten and a quarter pounds, was purchased by this laboratory. She had been captured a few miles east of Panama City a day or two previously. This animal was purchased principally for the study of her external and internal parasites. It was also proposed to ascertain if she would be effective in the extermination of numerous small colonies of ants that were attempting to establish themselves in the laboratory yard.

Since the large yard surrounding the laboratory is enclosed by a concrete wall, the anteater was turned loose in order that she might seek ants. She soon located a nook in an angle of the basement wall of the laboratory in which she spent the days lying curled up with her nose tucked between her paws. With the coming of dusk each evening she became active and began moving rapidly about the yard with a waddling gait. Locating the ants seemed to be done mainly with her nose and when they were found her long, slender, ribbon-like tongue rapidly collected them.

A small building used for an insectary in the yard was surrounded by a concrete trough that was kept filled with water to act as a moat to prevent ants from gaining entrance. This moat was about ten feet in length on each of the four sides and the water in it was fifteen inches wide and from six to nine inches deep.

It was noted that as soon as the anteater became active in the evening she went to this moat to obtain a drink of water and to defecate before

beginning her hunt for ants. On the first two nights the stools were deposited on the ground at the edge of the moat. The stool deposited on the second night was large and well formed. It somewhat resembled the stool of a dog and emitted an extremely strong odor. Upon examination it was found that approximately 90 per cent of the stool consisted of undigested, hard, chitinous parts of ants. The other 10 per cent was made up of digested matter, flakes of rotten wood, tiny pebbles and fragments of stone. On the third night and on each night thereafter, with but one exception, while the observations were carried on, the stools were deposited in the water of the moat.

No further attention was given to the feces of this anteater until the morning of April 4th, when it was noted that the stool deposited in the water during the previous night contained three long, living worms belonging to the Acanthocephala. These were examined and found to be female specimens of *Gigantorhynchus echinodiscus*.

During the following eight days the stools of this anteater were collected each morning and examined for specimens of this worm. From one to three were found to be present each day except on April 10th, when the stool excreted that day was deposited on the ground at the side of the moat. It is suspected that if any worms were present in this stool they either disappeared in the grass or crevices of the ground or furnished a breakfast for some early bird. Two stools were deposited in the water on the night of April 7th and also on April 12th, and a worm was found in each stool on both occasions.

Much to my regret the anteater disappeared on the night of April 13th. It is quite probable that she was stolen.

During the nine days that the stools of this animal were examined a total of fourteen worms were collected. These consisted of six males and eight females. It would be of considerable interest to be able to definitely account for this daily spontaneous elimination of these worms. It is possible, but hardly probable, that the animal may have been so heavily infested that the passage of the worms was due to a resistance that was being acquired. It seems more likely, however, that some factor produced by captivity may have been the cause. The theory has sometimes been advanced that the diet of a host animal may exert considerable influence on its parasites. Such may have been the case in this instance. Lack of proper intestinal contents with a change in the digestive juices may have exerted an influence. It was noted that the amount of earth present in the feces of the anteater increased during the period of her captivity. An examination of a stool passed on April 10th showed that approximately 30 per cent of it consisted of earth, gravel, etc. This was an increase of about 20 per cent of such material over that found in the stool examined on April 1st. This may have been due to the fact that

the longer the anteater remained in the yard and continued to consume the ants the scarcer the latter became. Possibly in licking them from the ground in smaller numbers she may have taken up more earth with her tongue than she ordinarily would have done when taking them from larger colonies. It was also possible that the earth or water may have contained ingredients from construction material used in building the recently erected concrete laboratory and wall that acted as a vermifuge. Although the first specimens observed were found on April 4th, there is no certainty that they were not being expelled during the first days in captivity, except that none were found in the feces examined on April 1st. The disappearance of the animal prevented an examination at autopsy that was planned when and if the worms ceased to appear in the feces.

A second anteater of the same species was later obtained. This was a young, adult female that was so intractable that she was sacrificed. Upon being autopsied two specimens of the worms, a male and a female, were found in the cecum. It is hoped that further observations on the occurrence of *G. echinodiscus* in Panama may be made.

ACKNOWLEDGMENT

I wish to express my thanks and appreciation to Dr. M. C. Hall and other personnel of the Zoological Division of the U. S. Bureau of Animal Industry for their kindness in confirming my identification of these parasites.

REFERENCES

1. Travassos, L. 1917.—Contribuicoes para o conhecimento da fauna helmintolojica brazileira. Memorias do Instituto Oswaldo Cruz. Tome IX, p. 29.
2. Strong, R. P., Shattuck, G. C., Bequaert, J. C., and Wheeler, R. E. 1926.—Medical Report of the Hamilton Rice Seventh Expedition to the Amazon, in Conjunction with the Department of Tropical Medicine of Harvard University, pp. 110 and 125. Harvard University Press, Cambridge, Mass.

STUDIES ON COCCIDIOSIS V. TREATMENT WITH POWDERED BUTTERMILK

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In the following pages are reported the data which have been accumulating for some time in the Department of Parasitology of the Louisiana Experiment Station on the use of a 40 per cent buttermilk mash in the treatment of coccidiosis. It became evident very early in the course of the experiments that certain difficulties, due to the characters of the disease, stood in the way of a rapid and accurate checking of the results of any method of treatment that might be employed. One of these characteristics is the mortality rate. It was expected in the first experiments carried out that deaths would occur over a period of weeks as reported by many observers. This was found not to be the case. The results on this point are being offered in a separate paper (Mayhew, 1933) and show that over 90 per cent of the deaths occur during the 5th, 6th, and 7th days after inoculation when the conditions of the environment as to temperature, handling, etc., are carefully controlled. Eight per cent of the remainder is believed to have been caused by other factors beyond the control of the experiments, the details of which are reported in each individual case. Obviously the death rate is distributed over too short a time to be of value in judging the results of any method of treatment that might be applied. For further details on this point the reader is referred to Mayhew (1933).

There seems to be much confusion in discussions of coccidiosis relative to the terms treatment and prevention. Methods of treatment of a disease are employed after the presence of the disease has been definitely determined and are designed to assist in the recovery of the patient, while preventive measures are used to prevent infection or to prevent the development of the disease should the organisms gain access to the body. In designing these experiments an attempt has been made to separate these two phases, and treatment, in this case a 40 per cent powdered buttermilk mash, begun after the disease has definitely appeared. This procedure corresponds to the needs of a poultryman when an epidemic develops in his flock. Experiments on the use of buttermilk in prevention are nearly completed and will be reported later.

Reference to a few of the recommendations and descriptions of the experiments of others are now made. Beech and Freeborn (1930) recommend the feeding of the 40 per cent buttermilk as soon as the presence of the disease is determined. Beech and Carol (1925) began treatment of naturally infected chicks when they were visibly sick, and in the

same paper reported results on inoculated chicks starting treatment immediately following inoculation. Sherwood (1925) combines treatment and prevention in the same experiments. Chandler (1932) supplies several percentages of buttermilk at the time of inoculation and continues over a period of several weeks during a series of inoculations, thus combining treatment and prevention.

METHODS OF PROCEDURE

The chickens used in these experiments were single comb Rhode Island Reds, hatched from the author's flock of hens or from the pullets reared in the earlier experiments on this disease. A total of 349 individuals including 166 inoculated and 183 control birds hatched in 12 lots, as described in Table 3, form the basis for the data. All lots were reared by the same methods for the details of which the reader is referred to Mayhew (1932a) and (1932b). A commercial starting mash which contained about 5 per cent powdered buttermilk, according to the manufacturer, was fed until they were 8 weeks of age. For purposes of treatment 35 per cent powdered buttermilk obtained from the Kent Dairy Products Corporation of Aberdeen, Mississippi, was added, thus making approximately 40 per cent as recommended by Beech and Freeborn (1930). For a description of the methods used in controlling the brooding conditions, the reader is referred to Mayhew (1933). Between the ages of about 8 and 20 weeks the birds were kept in the shelters and sun porches described in Mayhew (1932a), and were fed growing mash and grain made by the same manufacturer as was the starting mash. Grain was fed twice daily throughout the experiment after the first two weeks, the baby chick size until 8 weeks of age and the size recommended for growing chickens from then until 20 weeks.

Inoculations were made when the chickens were 42 to 46 days or a little over 6 weeks of age. A varying amount of the "culture," depending upon its estimated strength as determined by microscopic examination, was introduced into the crop by means of a glass tube and rubber bulb as described in the preceding papers of this series.

When the chickens became sick with the disease they were isolated in an especially constructed battery in the same room and a microscopic examination made of the droppings of each bird, the presence of hemorrhage determined, and the general severity of the attack of the disease in each individual bird noted. Fecal examinations of both controls and inoculated chickens were made before the inoculations and again about two weeks afterward to check the freedom of the controls and the general course of the disease in those surviving. In most of the lots in Series No. 1 fecal examinations of all birds were made at intervals of about a month until the end of the experiments. However, after making

1839 examinations of birds in the various types of experiments to check the correctness of the conditions, the practice of these later examinations was discontinued among the birds on treatment. No evidence of any other kind of parasitism was ever found in any of the chickens reared by these methods.

The typical course of the disease has been observed to be as follows: No symptoms are observed until the fourth day, when in some lots an occasional bloody dropping will be observed on the dropping boards. On the fifth day bloody droppings become numerous and many birds show evident symptoms and a number of deaths occur. On the sixth day the physical symptoms of the disease are the most marked and the largest number of deaths occur; while by the end of the seventh, many of the less severely affected individuals show improvement and some will begin to eat a little. The number of deaths are much less on the seventh day and on the eighth almost none die. With these observations in mind it was decided to begin treatment on the morning after the day of most severe sickness and the largest number of deaths, or the morning of the seventh day after inoculation. Since it is believed that, unless a poultryman was unusually familiar with the disease, he would not be able to make the diagnosis or consult someone qualified to do so, secure a supply of buttermilk and prepare the mixture to start the treatment much before this time.

At the time of starting treatment the surviving inoculated birds were divided into two groups at random, except that the very sick birds were equally divided, and each placed in one of the lower compartments of the battery in the inoculation room. The control birds were divided in a similar manner and placed in the two upper compartments. One group of the inoculated and one of the controls were then supplied with the 40 per cent butter-milk mash for a period of 2 weeks and the remaining two groups with the regular mash. At the end of the experiment the sex of each bird was noted, and thus each of the four original groups at the time of beginning treatment finally was divided into two according to sex. Each chicken was weighed each week from one week of age until the end of the experiment and its general condition noted each time. The feeding, watering and weighing of these birds have been done by the author in an attempt to eliminate errors from the results. A specially constructed Toledo counter scale has been used for taking the weights in all experiments on this disease.

The method followed in Series 2 differed somewhat from that in Series 1 except in the care of lot No. 31. In Series 1 a sufficient number of chickens was used to fill the available space in each inoculation, but this was found to have the disadvantage of considerable time lost before another lot could be inoculated, should too light an infection be obtained

for treatment. In Series 2 smaller lots were used differing in age by one week and each entire lot was either treated or untreated. In this manner the chickens reared at one time in Series 2 differed in age by as much as 4 weeks, but often considerable time was gained by this procedure. Series 2 also differed from Series 1 in that some of the chickens were hatched from the old hens furnishing the eggs for Series 1 and the remainder from the pullets reared in the experiments of Series 1. No differences of consequence were observable in the results obtained by this change in procedure.

CHEMICAL COMPOSITION OF THE BUTTERMILK

A sample of the powdered buttermilk has been analyzed in the Feeds and Fertilizer Laboratory of the Louisiana State University and the report on its chemical composition is as follows:

Crude Protein		34.56%
Fat		4.35%
Carbohydrates	N. F. E.	29.64%
	Crude Fibre	2.20%
Water		14.25%
Ash		15.00%
Lactic Acid		10.24%

GENERAL OBSERVATIONS

Very early in the experiments it was observed that recovery is so rapid in the case of most individuals under good conditions of feed, sanitation, and management that it was impossible to determine from their general condition which were controls and which inoculated birds. There were some cases in which the period of convalescence is greatly extended, but these are too few to be of value in judging methods of treatment. One of these cases is reported in Mayhew (1932a). It was, therefore, decided to retain the birds under experimental conditions as long as possible and collect data along as many lines as possible. Much of this data will be presented in later reports and will assist in answering several questions now in the minds of poultrymen relative to this disease.

A study of this data shows that the weights are the most accurate and definitely measureable criteria of measuring the effect of the disease on the birds. All chickens surviving the inoculations were kept and reared to 20 weeks of age regardless of whether or not hemorrhage had occurred or their weights had been severely affected individually. This was done in an attempt to approximate as closely as possible the results of a natural epidemic. In a natural epidemic, however, it would not be expected that the deaths would be restricted to quite as short a time because the ingestion of the infective material would be extended over a longer time, and, under the usual conditions of brooding and manage-

ment, the surrounding conditions of the environment would not be so closely controlled. This difference in weight is, also, of economic importance, since it represents a definite reduction of profits when birds are sold by weight. Whether chickens will be able to recover this loss in weight is a question which is being further studied, and some data already collected, which it is planned to present separately.

In Table 2 is stated the results of the inoculations in each group of chickens. It will be noted that the results vary greatly in different lots and that the death rate is not always an accurate estimate of the severity of the infection among the survivors. This is illustrated in the group of Lots 33 to 36, Table 3, where the number of deaths was more than half those inoculated, but among the survivors only about half were found to have hemorrhage. Again in Lots 40, 41, and 43, the mortality was less than half and hemorrhage was almost 100 per cent among the survivors. Obviously the later lot would be a much better one for purposes of treatment than the former, and that more and definitely favorable results of treatment would be obtained from the former. The percentages of deaths among the total inoculated was 33.4 per cent and 40.9 per cent of the total number of cases of hemorrhage died.

DISCUSSION OF THE RESULTS

It will be observed from Fig. 1 and Tables 1 and 2 that the weights of all groups of chickens are relatively the same up to the age of 6 weeks. During the 7th and 8th weeks, the two weeks following inoculation, there is a rapid and marked separation of the growth curves of the inoculated and the control groups. From the 9th week on the inoculated chickens gain regularly, but at no time during the experiment do their weights equal or exceed the weights of the controls. Further data on this point have already been presented in Mayhew (1932a & b). It will be observed that during the 9th week from Tables 1 and 2, the first week after recovery, about an average gain in weight is made by the inoculated birds and that it approximately equals that of the controls, also during the remaining weeks of the experiments the gains of the inoculated chickens closely resemble those made by the controls. It has been previously mentioned that the separation of chickens at the time of inoculation and of starting treatments was at random. However, when the weights of the various groups were separated by sex and averaged it was found that the weights of all inoculated groups were greater than those of the controls except in the regular mash males. On this basis it would be expected that the weekly difference between the inoculated and control males of the regular mash groups would be relatively greater than in the treated groups, and an examination of the growth curves in Fig. 1 and the percentage difference curves of Fig. 2 shows that this is

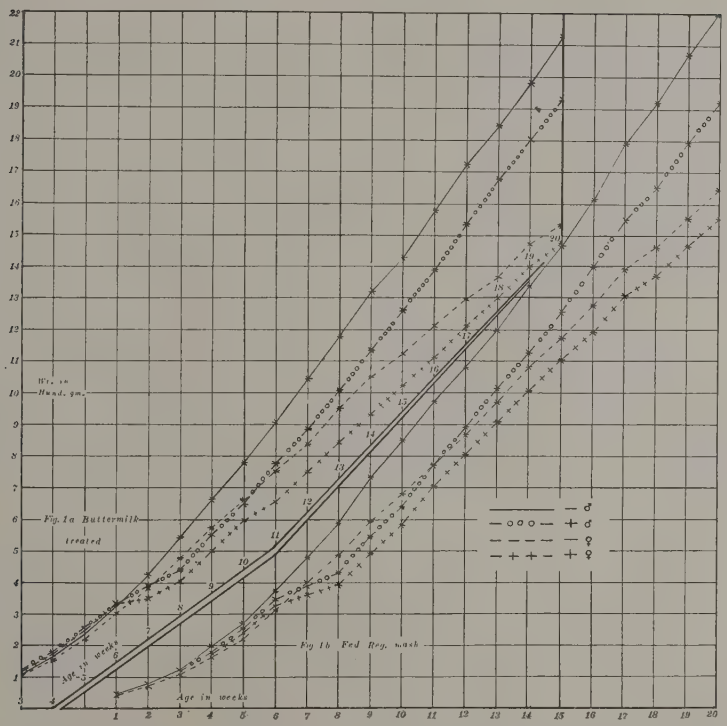

Fig. 1. Growth curves of the various groups of chickens. The buttermilk treated groups are represented in Fig. 1a, in the left upper portion, and the regular ration groups in Fig. 1b, in the lower right portion of the figure. For the number of individuals in each group the reader is referred to table 2.

the case. All curves in Fig. 1 represent the averages of all surviving birds in an attempt to approximate as closely as possible the results that a poultryman might have, should an epidemic develop in his flock. It is doubtful if the results would be as good, however, under the average conditions of brooding and management because of the more or less continued reinfection and the less accurately controlled temperature conditions. To obtain an average of the severely infected birds a selection of individuals that made little gain or that lost weight during the 7th and 8th weeks has been made from among those having hemorrhage. These results have been averaged and presented in Table 2 and the per cent difference plotted in Fig. 2. It will be observed that these results are considerably lower but that they closely resemble those obtained for the total.

Several investigators present data which show a marked increase in

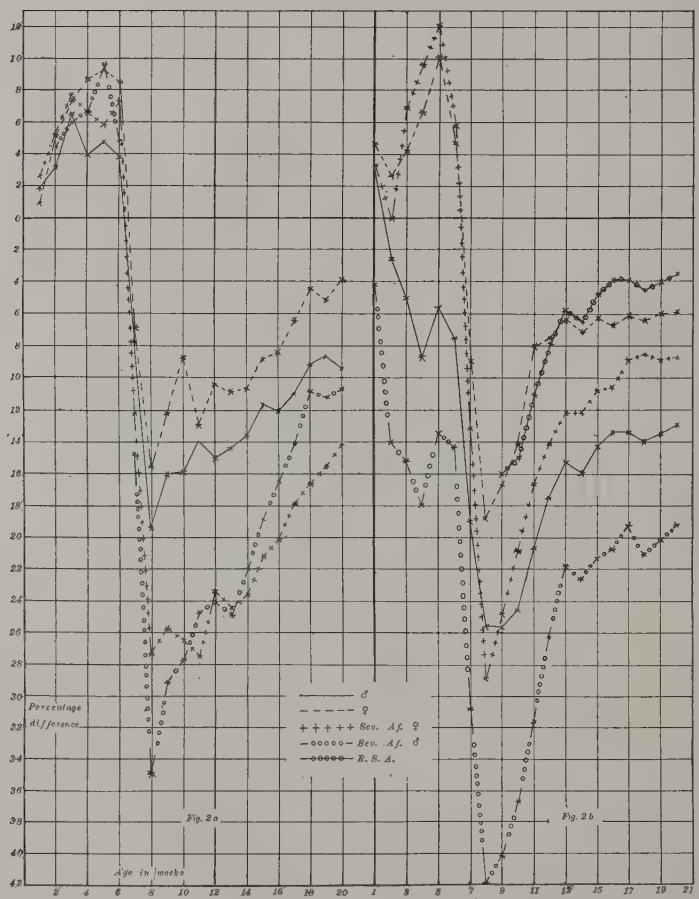

Fig. 2. Percentage difference plotted by weeks for the buttermilk treated chickens in figure 2a on the left, and for the regular mash fed birds in figure 2b on the right. A selection of very severely affected birds of both sexes from the buttermilk treated and untreated groups has been made. The percentage differences for these selected individuals are shown by the curves Sev. Af. ♀ and Sev. Af. ♂. In obtaining the percentage the difference between the two averages for any given week was divided by the larger average. The curve R. S. A. (fig. 2b) represents the averages of the total number of regular ration males starting at the same point on the chart at the 9th week as did the buttermilk treated males.

growth when buttermilk is fed to diseased birds as compared to that made when it is not provided in the ration. Sherwood (1925) found that inoculated chickens provided with buttermilk diluted with water in

the proportion of 1–3 and 1–6 weighed nearly twice as much at the end of eight weeks as those receiving no buttermilk. Chandler (1932) also reports that the birds receiving a 20 per cent and 15 per cent powdered buttermilk mash differed by about 100 grams at the end of the experiment. Data are lacking in their reports, however, which indicate the relative severity of the disease among the surviving chicks. It is not stated what proportion of the survivors developed hemorrhage and the degree to which their weights were affected immediately following the inoculation. These experiments were also conducted under the usual conditions of brooding and management, and, consequently, other factors no doubt entered into the death rate and gain in weight to some extent.

When the averages of the inoculated treated males are compared with those of the untreated, Tables 1 and 2 and Fig. 1, it is seen that they parallel very closely during the entire time of the experiment. It will be observed that the average of the "untreated" control males is consistently greater than the "treated" control males. In the case of the females of the similar groups the "treated" group is somewhat less in weight than the "untreated." The similarity between the curves of the various groups does not suggest that there is any injurious effect from the use of the buttermilk, as suggested by some. Neither does it seem to have any beneficial effect on the growth of any of the groups of the controls. It has been observed to have a laxative effect, the droppings becoming decidedly watery in all groups of chickens, and the author wishes to suggest that this may be an important factor in promoting the sporulation and infectivity of the coccidian oocysts since it has been shown in this laboratory as well as elsewhere that dryness destroys the organisms, and that, consequently the employment of buttermilk may actually interfere with the checking of epidemics under unsanitary conditions.

An examination of the percentage difference in Fig. 2 and in Table 2 shows that the treated females were slightly higher during the last three weeks but previous to this time they were much lower and did not seem to recover from the disease as rapidly. This should not however be attributed to any harmful effect of the buttermilk until more definite information is available. When the percentage difference of the males furnished with buttermilk is compared with those untreated, it is found to be much higher throughout the experiment but it will also be noted that the untreated group was 5.5 per cent below the weight of the controls at the time of the inoculation, while the treated group was nearly 4 per cent above. When the curve of untreated males is placed to correspond with the treated, as is done in Fig. 2, it is seen that the relative percentage is actually much less than it is with the treated males.

Comparatively little work seems to have been reported in which a study has been made of the effects of parasites upon the weights of the

TABLE I.—*Summary of all lots*

	Age in Weeks	Males								Females							
		Average Weights			Gain per Week			% Dif.		Average Weights			Gain per Week			% Dif.	
		Inoculated		Controls	Inoculated		Controls	Sev. Aff.	Total	Inoculated		Controls	Inoculated		Controls	Sev. Aff.	Total
		Sev. Aff.	Total		Sev. Aff.	Total				Sev. Aff.	Total		Sev. Aff.	Total			
A Group Buttermilk Treated	3	115.6	116.3	108.6	40.4	42.1	36.8	+ 6.05	+ 6.62	115.7	115.4	106.9	41.5	41.3	36.6	+ 7.60	+ 7.36
	6	343.1	339.5	326.5	83.3	93.3	92.1	+ 4.83	+ 3.82	326.4	330.3	302.4	94.2	89.2	83.7	+ 7.35	+ 8.44
	*7	360.3	389.7	422.5	17.2	50.2	96.0	-14.72	- 7.76	334.7	354.8	381.2	8.3	24.5	78.8	-12.19	- 6.92
	8	353.5	438.6	543.6	6.8	48.9	121.1	-34.97	-19.31	345.8	401.2	475.9	11.1	46.4	94.7	27.31	-15.62
	9	471.4	558.4	665.0	117.9	119.8	121.4	-29.11	16.03	423.7	500.7	570.5	77.0	99.5	94.6	-25.7	-12.23
	12	790.0	884.2	1041.1	110.8	108.3	139.1	-24.11	-15.07	641.0	750.0	837.1	94.2	93.9	83.3	-23.41	-10.40
	16	1315.4	1387.8	1577.8	160.8	129.4	152.7	-16.63	-12.04	968.3	1109.7	1212.2	85.0	87.1	90.8	-20.12	- 8.45
	20	1900.0	1927.7	2128.4	143.1	121.5	149.1	-10.73	- 9.43	1318.3	1475.5	1536.2	81.1	84.8	68.9	-14.18	- 3.95
	No. Chickens .	14	59	36						19	39	57					
B Group Regular Mash	3	105.4	118.0	124.3	37.1	40.5	44.7	-15.20	- 5.1	117.4	114.0	109.2	43.4	39.8	35.2	+ 6.98	+ 4.21
	6	320.1	345.7	373.8	87.3	91.8	104.8	-14.36	- 7.51	331.2	326.3	310.8	84.1	84.8	93.7	+ 6.15	+ 4.75
	*7	332.3	388.8	480.8	12.2	43.1	106.9	-30.88	-19.11	346.1	362.9	398.7	14.9	36.6	87.9	- 3.19	- 8.97
	8	343.0	438.3	589.3	10.7	49.4	108.5	-41.79	-25.62	344.6	393.7	484.8	-1.5	30.8	86.1	-28.91	-18.79
	9	438.4	543.6	732.2	95.4	105.2	142.8	-40.12	-25.70	447.0	495.0	594.2	102.0	101.0	109.0	-24.77	-16.7
	12	796.1	892.5	1080.9	132.3	121.9	110.0	-26.34	17.43	747.0	804.6	869.7	106.5	99.3	102.0	-14.10	- 7.48
	16	1278.4	1398.5	1613.2	126.1	143.4	149.0	-20.75	-13.30	1140.6	1190.0	1276.3	93.1	88.8	101.8	-10.63	- 6.76
	20	1780.0	1918.7	2203.5	126.2	125.6	131.6	-19.21	-12.92	1504.0	1551.3	1647.5	86.0	87.9	91.2	- 8.71	- 5.84
	No. Chickens .	13	36	45						17	32	45					

* Inoculated at this time.

TABLE 2.—*Details of the results of the inoculations with coccidia in each lot of chickens and the number of controls, birds of each sex, in the treated and untreated groups*

	Lot No.	Date Hatched	Tot. No. Inoc.	No. Deaths	Treated groups						Untreated groups					
					♂		♀		Controls		♂		♀		Controls	
					Tot.	Hem.	Tot.	Hem.	♂	♀	Tot.	Hem.	Tot.	Hem.	♂	♀
Series No. 1	21	5/7/30	29	1	12	7	2	2	6	2	5	4	9	6	2	6
	24	12/13/30	15	1	5	1	2	0	2	3	3	3	4	3	1	4
	28*	2/28/31	36	5	11	7	5	3	6	8	8	7	5	3	6	11
	30	6/1/31	12	2	0	–	5	5	1	6	5	3	0	–	5	–
Series No. 2	31	7/6/31	20	6	4	3	6	5	2	4	4	4	0	–	4	2
	33, 34, 35, 36*	10/13–11/3/31	73	41	19	8	11	6	6	5	0	–	0	–	21	15
	40, 41, 43**	2/17–3/8/32	72	30	8	8	8	8	13	29	11	11	14	12	6	7
Total			257	86	59	34	39	29	36	57	36	32	32	24	45	45

* 2 birds lost from other causes than Coccidiosis in these lots.
** 1 bird lost from other causes than Coccidiosis in this lot.
Percent of deaths among total number of cases of hemorrhage 40.9%.
Percentage of deaths among total number inoculated 33.4%.

host. Morris (1932) found that the weights of mules were an excellent index of the physical condition of the animals, and that they increased with each administration of an anthelmintic. Ackert and Herrick (1928) showed that the large roundworm, *Ascaridia lineata,* had a very injurious effect on the weights of growing chickens. These results together with those reported by Mayhew (1932a & b) emphasize the importance of parasitic control in all experimental work in which the general health of the animal is concerned.

STATISTICAL TREATMENT OF THE DATA*

A statistical study has been made of certain of the data, and a summary of the results is given in Table 3. Since the results among the regular mash groups of chickens are in a general way similar to those of the buttermilk treated groups, the figures have not been worked out except for the treated groups. The figures have been completed for only the 6th, 8th and 20th weeks for the total number of birds in Series 1 and 2 for the same reason.

The formulae employed in obtaining these results are as follows:

$$\text{Standard deviation } \sigma = \sqrt{\frac{\Sigma (x_1 - X_2)^2}{n-1}}$$

$$\text{Standard deviation of the mean } \sigma m = \frac{\sigma}{\sqrt{n}}$$

Standard deviation of the mean difference

$$\sigma md = \sqrt{\frac{\sigma m^{-2}}{n} + \frac{\sigma m^{+2}}{n}}$$

$$t = \frac{md}{\sigma md}$$

It will be noted that highly significant ts are obtained in all cases except in the case of the males of Series 1 before the birds became ill with the disease. It will be noted, however, that the weights of the inoculated groups averaged heavier before inoculation than the control, consequently the significance is reversed at the time of the attack of the disease.

SUMMARY

1. Weight is the most definitely measurable difference between chickens inoculated with coccidia and their controls.

2. Data are presented on 349 birds reared from 12 lots and in 7 different groups.

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* The writer is indebted to Dr. J. R. Fowler, of the Zoology Department, and to Mr. C. W. Upp, of the Department of Poultry Research, Louisiana State University for assistance in the statistical treatment of the data.

TABLE 3.—*Summary of the results of the statistical treatment of the data of the buttermilk treated groups of chickens of Series No. 1 and of Series No. 2 separately and of the total of the two series*

	Age in Week	Inoculated		Uninoculated			
		n	σ^m	n	σ^m	σ^{md}	t
Ser. 1 males	4	28	6.11	15	9.39	2.68	+ 0.783
	6	28	11.11	15	15.54	4.52	- 1.50
	8	28	21.42	15	20.26	6.61	-23.66
	14	27	131.53	12	62.25	30.60	- 7.068
	20	24	168.14	12	91.64	43.31	- 6.303
Ser. 2 males	4	31	7.28	21	7.28	2.05	+ 5.60
	6	31	11.26	21	11.85	3.28	+ 8.68
	8	31	21.36	21	19.19	5.67	-12.22
	14	31	41.08	21	39.37	11.32	-16.89
	20	30	75.44	21	46.90	17.15	-11.07
Total of Ser. 1 & 2 males	6	59	7.88	36	9.51	1.887	+ 6.894
	8	59	17.69	36	16.96	3.64	-34.52
	20	54	51.22	33	51.84	11.40	-18.40
Ser. 1 females	4	14	7.90	19	5.49	2.45	+ 5.40
	6	14	12.63	19	9.48	4.01	+ 4.23
	8	14	23.56	19	15.66	7.24	-15.04
	14	13	69.76	19	30.13	20.54	- 5.12
	20	13	70.99	19	47.70	22.52	- 3.06
Ser. 2 females	4	25	6.27	38	4.09	2.01	+ 7.71
	6	25	8.17	38	6.44	1.93	+17.04
	8	25	15.81	25	13.47	4.15	-15.32
	14	25	31.35	38	22.80	7.27	-15.88
	20	25	46.69	37	23.80	10.12	- 5.78
Total of Ser. 1 & 2 females	6	39	6.87	57	5.49	1.318	+21.15
	8	37	13.49	57	10.41	2.6	-27.21
	20	37	41.65	56	25.07	7.62	- 8.51

Plus signs (+) are placed before the t in each case where the weights of the inoculated birds were heavier than the controls before inoculation and minus signs (−) when their weights became less than that of the controls. Inoculations were made during the early part of the 7th week.

3. Data are presented on 63 severely affected birds selected from the total number of infected individuals.

4. The results obtained indicate that there are no beneficial results obtained on the weights by the use of a 40 per cent buttermilk mash in the treatment of coccidiosis.

5. The percentage difference between the weights of the diseased and the control birds is a measure of the direct economic loss resulting from a severe epidemic of coccidiosis, since it represents a direct loss in profit when birds are sold by weight.

6. The results emphasized the importance of parasitic control in such types of experimental work involving the continued general good health of animals.

7. The observations indicate the necessity of complete data, such as individual fecal examinations, diagnosis of hemorrhage, and frequent weights, as measures of the results of treatment of coccidiosis in chickens. Emphasis should be placed upon environmental conditions surrounding the birds during the period of convalescence. In fact, it is believed that better conditions must be provided than is practicable or economical for most poultrymen to provide or the death rate will be influenced by other factors than the disease.

Bibliography

Ackert, James E., and Chester A. Herrick. 1928.—Effects of the nematode, *Ascaridia lineata* (Schneider) on growing chickens. Jour. Parasitology, 15: 1–13.

Beach, J. R. 1917.—Bacillary white diarrhoea or fatal septicemia of chicks and coccidiosis or coccidial enteritis of chicks. Univ. of California. Agri. Exp. Sta. Cir. No. 162, 8 pp.

Beach, J. R., and J. C. Corl. 1925.—Studies in the control of coccidiosis. Poultry Science, 4:83–93.

Beach, J. R., and D. E. Davis. 1925.—The influence of feeding lactose or dry skim milk on artificial infection of chicks with Eimeria avium. Hilgardia, 1:167–181.

Beach, J. R., and S. B. Freeborn. 1930.—Diseases and parasites of poultry in California. California Agri. Ext. Cir. No. 8, 73 pp.

Chandler, W. L. 1932.—On the control of caecal coccidiosis in chickens. Mich. State College Agri. Exp. Sta., Tech. Bul. No. 127, 24 pp.

Mayhew, Roy L. 1932a.—Studies on Coccidiosis I, The effects of coccidiosis upon the weights of chickens artificially inoculated during the seventh week. Poultry Science, 11:34–9.

1932b.—Studies on Coccidiosis II, The effects of coccidiosis upon the weights of chickens artificially inoculated during the thirteenth and fourteenth weeks. Poultry Science, 11:102–5.

1932c.—Studies on Coccidiosis III, Observations on Paralysis with special reference to Coccidial infection. Poultry Science, 11:289–92.

1933.—Studies on Coccidiosis IV, Mortality and infection results among artificially inoculated chickens. Poultry Science, 12:206–10.

Morris, Harry. 1932.—A study of intestinal parasites in horses and mules in Louisiana, with special reference to the control of colic. Jour. Am. Vet. Med. Assn., 80:11–17.

Sherwood, R. M. 1925.—The value of various feeds in the control of coccidiosis. Texas Agri. Exp. Sta. Bul. No. 331, 14 pp.

RESEARCH NOTES

THE PARASITISM OF LIZARDS BY *IXODES RICINUS CALIFORNICUS*

Ixodes ricinus californicus (Banks) has been reported from mammalian hosts in the Pacific Coast states (Banks, U. S. Dept. Agri., Bur. Ent., Tech. Ser., No. 15, 1908) and has recently been found in British Columbia by Eric Hearle, Entomological Branch, Canadian Department of Agriculture.

The adult tick is a serious pest of deer, livestock and dogs and frequently bites man, often inflicting painful, slow-healing wounds. There are extensive host records for all stages of *I. ricinus* in Europe (Nuttall and Warburton, Ixodidae—Pt. II of Ticks: A Monograph of the Ixodoidea. Cambridge University Press.) but none for the larvae and nymphs of the Pacific Coast variety.

While engaged in field studies relative to the occurrence of Rocky Mountain spotted fever virus in California ticks, during March and April, 1932, the author made numerous collections of *I. ricinus californicus* in Madera, Monterey, San Benito, Santa Barbara, Santa Clara and San Luis Obispo counties. Unfed adults were secured from vegetation in considerable numbers and also were found infesting dogs, horses and man. The hosts of the immature ticks were alligator and blue-bellied lizards except that in one instance an engorged nymph was taken from a dog. The lizards have been identified by Miss Doris M. Cochran, of the United States National Museum, as *Gerrhonotus scincicauda scincicauda* and *Sceloporus occidentalis occidentalis,* respectively. The larval and nymphal ticks were attached in the lateral cervical pouches of the lizards, where they were concealed and protected to a considerable extent. Adults, both male and female, were reared from engorged nymphs taken from these lizards. Later five lizards (collected at Orleans, Humboldt County, California, May, 1933) were received from Mrs. Vera Kistner. These have been identified by Dr. Doris M. Cochran, of the National Museum, as *Sceloporus occidentalis occidentalis* (4 specimens) and *Gerrhonotus coeruleus* (1 specimen). All were infested with larvae and nymphs of *Ixodes ricinus californicus.*

The considerable population of lizards and the number of ticks present on them suggest to the author that they are important hosts of the immature stages of the tick concerned. In a restricted area south of Monterey High School, Monterey County, where tick infested lizards were very numerous, over 250 adult ticks were collected from vegetation in a few hours. In this area no rodents or other small animals that might serve as hosts to the immature ticks were seen, although they might have been present in limited numbers.

Parasitism of lizards in Europe by *I. ricinus* is recorded by Nuttall and Warburton (l. c.) and by Neumann (Ixodidae. Das Tierreich, Lief. 26. R. Friedlander and Sohn). Dr. Brumpt, Professor of Parasitology of the University of Paris, has informed me that he has used lizards for the rearing of *I. ricinus* but that in Europe they are considered as occasional and unimportant hosts.

The California collections of *I. ricinus californicus* were as follows:

Drag ticks, which are adults collected by dragging a white flannel cloth over grass, low shrubs or other vegetation, were collected at Bass Lake, Madera county; Monterey, Monterey county; Pinnacle National Monument, San Benito county; San Marcos Pass, Santa Barbara county, and at Mt. Hamilton, Monte Bello and Stevens Creek, Santa Clara county. Adult ticks were found infesting dogs and horses at Bass Lake and Morgan Hill, Santa Clara county.

Except for the engorged nymph noted as found on a dog (Morgan Hill) all larvae and nymphs were taken from *Sceloporus occidentalis* at Monterey, Willow Mountain, San Benito county and Pioneer Camp, San Luis Obispo county and from *Gerrhonotus scincicauda,* collected in See Canyon, San Luis Obispo county. —Wm. L. Jellison, *The Rocky Mountain Spotted Fever Laboratory, United States Public Health Service, Hamilton, Montana.*

A PROBABLE CASE OF NON-SPECIFIC IMMUNITY BETWEEN TWO PARASITES OF CISCOES OF THE TROUT LAKE REGION OF NORTHERN WISCONSIN

It has been noted by several investigators that the presence of large numbers of one species of parasites has a tendency to limit infection by other parasites. Ward (Trans. Amer. Fish. Soc., 1911, 207) states: "Few fishes shelter equal numbers of all kinds of parasites and no species is recorded as heavily infected with all four groups of intestinal worms." Wilson (Bull. Bur. Fish., 34: 333, 1914) in a study of the glochidia of fresh-water mussels, showed that fish heavily infected with copepods were either very lightly or not at all infected with glochidia. He found also from the examination of field specimens that those fish harboring a large number of glochidia had few or no copepods. Leigh-Sharpe (Parasit., 25, 1933) says: "Monogenetic trematodes were found in greater abundance on the gills of fishes than parasitic copepoda and seemed mutually exclusive." Nolf and Cort (Jour. Parasit., 20: 38, 1933) found, in the case of groups of snails infested with larval stages of a schistosome, evidence of a non-specific immunity to infection by metacercariae of a strigeid trematode, *Cotylurus flabelliformis*.

As part of the fish parasite investigation fostered by the Wisconsin Geological and Natural History Survey, a catch of 92 ciscoes from Silver Lake were examined in 1933. In this group no parasites were found other than adult cestodes of the species *Proteocephalus exigus* and Acanthocephala of the genus Neoicanthorinchus. In the series of 92 fish the average number of tapeworms harbored was 16.92 and the average number of acanthocephala was 8.3. Of these fish 84 harbored tapeworms, 73 harbored acanthocephala and every fish had one or both parasites.

The degree of infection of this group of fish is plotted in Figure 1. From this graph it will be seen that those fish having 15 or more acanthocephala had a very limited infection with tapeworms. Conversely those harboring more than 25 tapeworms had few or no acanthocephala. The fish with fewer parasites often have them quite evenly divided between the two types.

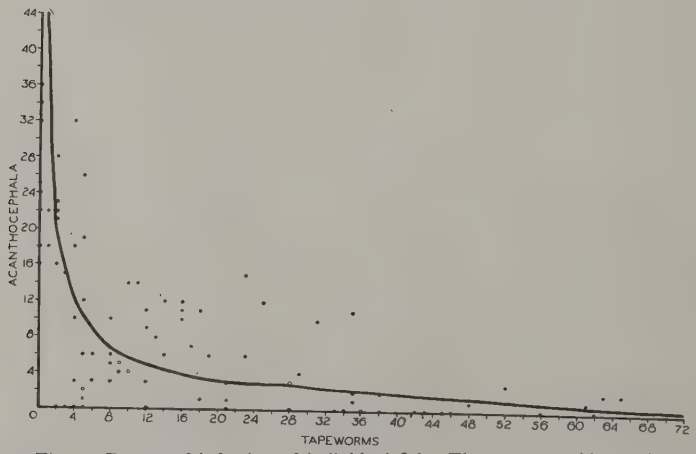


Fig. 1. Degree of infection of individual fish. The curve on this graph was located from a free hand line drawn on a logarithmic graph.

One dot represents 1 fish.

One circle represents 2 fish with similar infections.

In Table 1 the first group is made up of all fish harboring 28 or more tapeworms. Remembering the average tapeworm and acanthocephala infections it is evident that the tapeworm infection in this group is far higher than average

TABLE 1.—*Averages of infections in arbitrary groups from Figure 1*

Limits of infection	Number of fish	Average tapeworm infection	Average acanthocephala infection
1. 28 tapeworms or more	23	42.09	1.9
2. 20 acanthocephala or more	12	1.33	27
3. 15–25 tapeworms	13	19.53	7.3
4. 10–20 acanthocephala	22	11.7	13.59
5. 1–15 tapeworms	45	6.62	9.62
6. 1–10 acanthocephala	45	19.87	4.21

while the acanthocephala infection is only a fraction of the average for these worms. In the second item in Table 1 the high acanthocephala infections are averaged using those cases with 20 or more of these worms. Here the infection with acanthocephala is far above the average with tapeworms very low.

That this phenomenon is not due to crowding of the parasites in the intestine is evident when we consider that the two species occupy different parts of the alimentary tract, the tapeworms preferring the gastric caeca as points of attachment while the acanthocephala attach themselves near the middle of the intestine. With this in mind it seems reasonable to think of this situation as a result of a non-specific immunity limiting either tapeworms or acanthocephala when one of these parasites is present in large numbers.—SAMUEL X. CROSS, *Limnological Laboratory, Wisconsin Geological and Natural History Survey.* (Note No. 53.)

FURTHER STUDIES ON POST-TREATMENT REINFECTION WITH ASCARIS IN THE UNITED STATES

An earlier study by one of us (Otto, Jour. Amer. Med. Assoc., 95:194, 1930) in southwestern Virginia showed that ascaris infestation in a treated group had returned to the pre-treatment level in less than 11 months. Investigations in the tropics (Cort, Schapiro, and Stoll, Amer. Jour. Hyg., 10:614, 1929; Zschucke, Arch. Schiffs- u. Tropenhyg., 29 (Beihefte 2):5, 1925) have shown an even more rapid rate of reinfection. In the summer of 1930 in eastern Kentucky we were able to follow the return of the ascaris infestation in a series of school children treated with hexylresorcinol (Lamson, Brown, Ward and Robbins, Proc. Soc. Exper. Biol. and Med. 28:191, 1930). We are indebted to these workers for the use of their original data on the effects of the treatment in this series.

In this study we started with nearly 300 children treated with various doses of hexylresorcinol, 90 per cent of which had harbored ascaris. However, it proved impossible to get fecal specimens from all of these individuals at each of the desired intervals. The results are, therefore, given in three tables, each of which includes a different combination from the series. All fecal examinations, as in our previous studies, were made by the Stoll dilution egg counting method (Cort, Otto, and Spindler, Amer. Jour. Hyg., 11:1, 1930). The average of two egg counts on each specimen was used in compiling the data in this study.

Table 1, based on 125 children, shows the degree of reinfestation within five months after treatment. Though there is a striking reduction following treatment, the second post-treatment examination shows a rapid return of the worm burden in five months. Over half of those negative immediately after treatment

have been reinfected and the mean egg count of those positive approaches the pre-treatment level. Table 2, based on 135 children, shows the same reduction from treatment and a complete return of the infestation in eight months. In

TABLE 1.—*Showing the reinfection with ascaris within five months after treatment in the 125 school children which were examined at each of the indicated intervals*

Examinations	Relation to time of treatment	Per cent positive	Average egg count (per cc. of feces)	Mean egg count of those positive (per cc. of feces)
Pre-treatment (July and August 1930)	1–2 weeks before	100	22,400	22,400
First Post-treatment (Aug. and Sept. 1930)	2–3 weeks after	53	5,150	9,600
Second Post-treatment (Dec. 1930 and Jan. 1931) ..	5 months after	78	15,200	19,400

TABLE 2.—*Showing the degree of reinfection with ascaris within eight months after treatment in the 135 school children which were examined at each of the indicated intervals*

Examinations	Relation to time of treatment	Per cent positive	Average egg count (per cc. of feces)	Mean egg count of those positive (per cc. of feces)
Pre-treatment (July and August 1930)	1–2 weeks before	100	25,400	25,400
First Post-treatment (Aug. and Sept. 1930)	2–3 weeks after	52	4.950	9,400
Third Post-treatment (March and April 1931)	8 months after	85	29,300	34,400

TABLE 3.—*Showing reinfection with ascaris following treatment of the 102 members of the groups in Tables 1 and 2 for whom all four examinations were made*

Examinations	Relation to time of treatment	Per cent positive	Average egg count (per cc. of feces)	Mean egg count of those positive (per cc. of feces)
Pre-treatment (July and August 1930)	1–2 weeks before	100	23,000	23,000
First Post-treatment (Aug. and Sept. 1930)	2–3 weeks after	52	5,500	10,600
Second Post-treatment (Dec. 1930 and Jan. 1931) ..	5 months after	78	17,100	21,800
Third Post-treatment (March and April 1931)	8 months after	85	33,000	38,700

Table 3 are given the data from the 102 individuals common to both Tables 1 and 2. Though the values for the egg counts differ somewhat from those in Tables 1 and 2 the same relative picture is presented by this smaller series. No signifi-

cance can be attached to the 15 per cent which remains negative after eight months, for of the 53 children, in Table 3, still positive immediately after treatment, six (over 11 per cent) were negative at the time of one or both of the subsequent examinations. Furthermore of nine individuals negative for ascaris in the pre-treatment series but treated in the same manner for other parasites and examined for each of the post-treatment series seven had acquired ascaris by the time of the third or fourth examination. The implications of such spontaneous losses and acquisitions of worms has been discussed in the earlier paper (Otto, *l.c.*).

The results of this investigation agree with those of the earlier study from southwestern Virginia and supplement that series in showing the amount of reinfestation in periods of five and eight months after treatment. Again the point should be emphasized that such rapidity of reinfection indicates the futility of attempting to control ascaris in community groups by mass treatment, especially where there is no improvement in sanitation.—G. F. Otto and W. W. Cort, *Department of Helminthology, School of Hygiene and Public Health, the Johns Hopkins University, Baltimore.*

INFECTIONS OF THE VAGINA OF RHESUS MONKEYS WITH *TRICHOMONAS HOMINIS* FROM MAN

Trichomonad flagellates have been recorded many times from both the large intestine and vagina of monkey and man. It is possible, but not yet definitely established, that the organisms that live in the intestine and vagina belong to the same species, and that the organisms that live in the monkey are specifically the same as those that live in man. The morphological differences, however, might be due to differences in the environment. Attempts to separate specifically the trichomonads from the two habitats by culture methods have not been very successful. Cross-infection experiments are difficult because man is not a satisfactory experimental animal and parasite-free monkeys apparently do not exist. Hegner and Ratcliffe (Jour. Parasit., 14:27, 1927) described trichomonads from the vagina of *Macacus rhesus* and for the sake of convenience gave them the name *Trichomonas macacovaginae*. Five years ago the writer (Hegner, Jour. Parasit., 14:261, 1928) published the results of transmission experiments with these organisms and with intestinal trichomonads from the rhesus monkey. The results favored the hypothesis that the two types belong to the same species. However, the vagina of one monkey was successfully infected with trichomonads from the vagina that had previously resisted infection with intestinal trichomonads.

A new series of experiments were begun on Nov. 8, 1932, to determine the infectibility of the vagina of *Macacus rhesus* with *Trichomonas hominis* from the intestine of man. Four rhesus monkeys were used in these experiments. Fresh smears were made by washing out the vagina with warm culture medium and cultures were inoculated with vaginal washings. The culture medium used consisted of 0.5 per cent Loeffler's dehydrated blood serum in 0.75 per cent NaCl; 10 cc. of culture medium was used in each test-tube and incubated at 35° C. The vagina of each monkey was washed out nearly every day. Fresh smears were examined at once and the cultures were examined on the second, third and fourth days following.

Data obtained from monkeys 1 and 2. Between Nov. 8 and Nov. 22 smears and cultures were made on 11 days. None made from vaginal washings were found to be positive. Cultures from the feces of monkey 1 were positive for *Trichomonas* on 4 days and of monkey 2 on 3 days.

On Nov. 22 and again on Nov. 23, 5 cc. of culture medium containing an abundance of *T. hominis* were inoculated into the vagina of each monkey. Smears from both monkeys were positive on Nov. 25 but never thereafter. Cultures from monkey 1 were positive on 7 days up to and including Dec. 13 and from monkey

2 on 4 days up to Dec. 5. On Dec. 13, 15 and 17 the vagina of monkey 1 was irrigated with 20 cc. of 0.5 per cent formalin. Formalin in this strength had previously been found to be lethal to *T. hominis* in culture (Hegner, Amer. Jour. Hyg., 19:22, 1934). No trichomonads were recovered from this animal on 8 days between Dec. 17, 1932, and Feb. 20, 1933. An inoculation with a pure culture of *T. hominis* on Feb. 20, 1933, failed to infect as indicated by negative smears and cultures on 8 days up to March 21. Monkey 2 became negative 14 days after the first inoculation. It was inoculated again with a pure line on March 8 and was then positive 11 days.

Data obtained from monkeys 3 and 4. Experiments on monkeys 3 and 4 were begun on Nov. 22, 1932; both smears and cultures were negative on 4 examinations. *T. hominis* in culture were then inoculated into the vagina. Monkey 3 gave one positive culture 6 days later but was negative on 17 days up to Feb. 13, 1933. It was inoculated again on Feb. 20 and on March 8 but did not become infected. Monkey 4 was positive by smear on 3 and by culture on 5 of 6 examinations from Nov. 28 to Dec. 13. On the latter date the vagina of this animal was irrigated with 0.5 per cent formalin. The trichomonads promptly disappeared. It was inoculated with *T. hominis* in culture on Feb. 20 and Mar. 8 but did not become infected.

Conclusions. *Trichomonas hominis* from the intestine of man is able to live in the vagina of rhesus monkeys for a period of at least 20 days. The length of the infection differed in different monkeys. No evidence of multiplication was obtained. It seems probable that the infections were temporary and that *T. hominis* from man cannot maintain itself as a continuous infection in the vagina of *Macacus rhesus*. Irrigation of the vagina with 0.5 per cent formalin is completely successful for disinfecting purposes; its use in human infections is suggested.—Robert Hegner, *the Johns Hopkins University School of Hygiene and Public Health.*

THE LIFE CYCLE OF THE TURTLE TREMATODE, *CERCORCHIS MEDIUS*

Cercorchis medius was first described by Stunkard (1916) as *Telorchis medius*. The characteristics of the two genera, *Telorchis* Looss (1899) and *Cercorchis* Lühe (1900), were not clearly defined. Stunkard considered them synonymous. Perkins (1929) redefined the two genera and definitely separated them, transferring all North American species of *Telorchis* to *Cercorchis*.

The cercaria of *C. medius*, a Xiphidiocercaria, was found in *Physella integra*, collected in the region of the University of Michigan Biological Station on Douglas Lake. It develops in long snake-like sporocysts, measuring about 1.5 × 0.13 mm. The body of the cercaria is covered with fine spines, with a ruff of several rows of heavier spines around the oral sucker. The stylet is weak, has a small shoulder and measures 22 μ in length. It has been impossible to get an accurate count of the number of stylet glands but there are about 10 pairs. The oral sucker is larger than the acetabulum. Prepharynx and esophagus are both present and have about the same length. The intestinal ceca extend almost to the posterior end of the body. The tail is long and without a fin fold. At the base of the tail are two lateral rows of large spines. The excretory bladder is large, Y-shaped, with the arms extending to the posterior border of the acetabulum. The excretory tube enters the arm of the bladder posterior to the tip; at the lateral margin of the body it branches into an anterior and a posterior tubule. The flame cells and smaller tubules have not been seen.

In working with several species of stylet cercariae the author has found what seems to be a correlation between the strength of the stylet and the type of second intermediate host. The Xiphidiocercariae with heavy stylets use insect nymphs and other arthropods. Those with weak stylets penetrate into soft-bodied animals, usually larvae of Amphibia. The cercaria of *C. medius* is of the

latter type. Tadpoles serve as the second intermediate host. The cercariae were found to penetrate actively through the skin and to encyst in the underlying tissues. While encysted the metacercaria increases somewhat in size and the anlagen of the reproductive organs can be seen. The ruff of heavy spines around the oral sucker is quite noticeable.

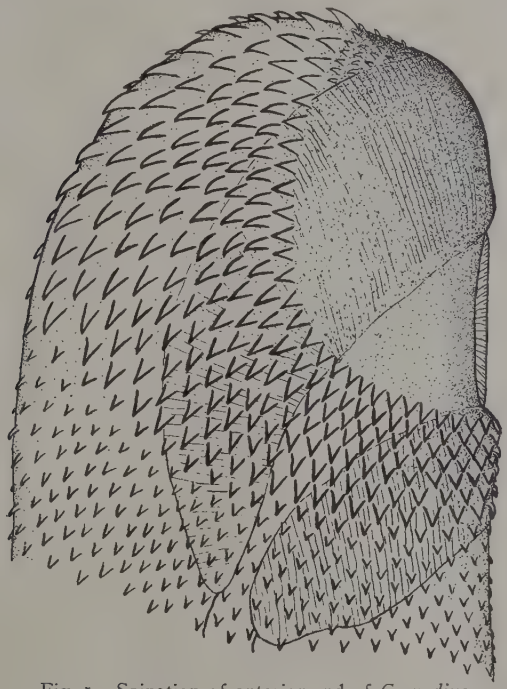


Fig. 1. Spination of anterior end of *C. medius*.

Experimentally infected tadpoles were fed to the painted turtle, *Chrysemys picta*, and to species of *Thamnophis*. A week after feeding, developing forms were found in both hosts. A month after feeding, those found in the garter snake were much smaller and development had been retarded. Other developmental stages up to the adult, which develops in about 6 months, were recovered from experimental turtles. The stem and arms of the excretory bladder become quite long. In the very early stages the ovary is found developing at the posterior right-hand margin of the acetabulum. The testes at the same time are oblique and

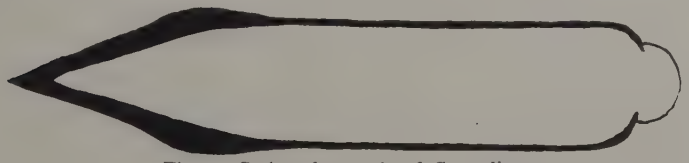


Fig. 2. Stylet of cercaria of *C. medius*.

not at the extreme posterior end of the body. This arrangement of the reproductive organs at this stage is like that found in adults of the Plagiorchidae. As development continues and the postacetabular region elongates the organs rapidly take the positions normally found in telorchids, *i.e.*, ovary median and just in front of the bifurcation of the bladder and the testes in the posterior end of the body and tandem. The characteristic spination of the cercaria and metacercaria is also found in the adult. This has not been previously described and after examining type specimens of *Cercorchis medius* and several other species of *Cercorchis*, it is believed that a study of the spination is important in determining species.

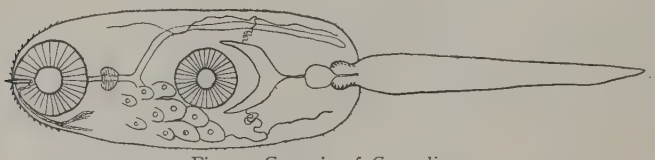


Fig. 3. Cercaria of *C. medius*.

The relationship of the telorchids to the other groups of trematodes has been somewhat speculative. Various authors have suggested that they are related to the Opistorchidae, Echinostomidae, Bunoderidae, and Plagiorchidae. No really definite conclusion is possible until the life cycles of the species are known. The life cycle of *Cercorchis medius* supports the view that the telorchids are related to the Plagiorchidae.—Donald B. McMullen, *Department of Biology, Monmouth College.*

THE OCCURRENCE OF A DISTOME METACERCARIA IN A BROWN RAT

Early in the year of 1933, while examining a local brown rat, *Epimys norvegicus*, for parasitic infestations an interesting distome metacercaria was found encysted in the muscles of the diaphragm. This is apparently the first record of a trematode larva encysted in rat muscle. Nelly J. Bosma (Science, 74:521, 1931) reported an experiment in which laboratory raised white rats were infected with the metacercaria of *Alaria mustelae* Bosma; however, there appears to be no record of a natural infestation in wild rats. For this form I propose the name

Agamodistomum norvegicum n. sp.

Specific diagnosis.—Distomata: In the living condition the larva is active. The white cyst measures about 0.5 mm. in diameter. The cyst wall consists of two layers, the outer one of loose texture and slightly thinner than the inner and more compact layer which measures 25 μ in thickness. Metacercaria ovoid, length 440 μ and width 340 μ. Acetabulum 40 μ by 53 μ, situated between the two intestinal cruri, 190 μ from the anterior end. Oral sucker subterminal, 36 μ in diameter. Muscular pharynx about one-half as large as oral sucker and situated at the end of a short pre-pharynx. Oesophagus slightly longer than pre-pharynx and about equivalent in length to the diameter of the oral sucker. Intestinal cruri enlarge considerably a short distance from the point of their origin at the end of the slender oesophagus, and extend back to within 80 μ of the posterior end of the worm. Maximum width of one ramus 50 μ. The primordia of the reproductive organs are in evidence in the posterior third of the body between the intestinal cruri; they could not be differentiated as to parts. No gland cells were observed and nothing of the excretory system was recognized.

Type specimen.—U. S. Nat. Mus. Helm. Coll. No. 8667.

Host.—Epimys norvegicus, the brown rat.

Location.—Diaphragm muscle.

Locality.—Sterling, Kansas.

Of the several species of metacercaria mentioned by Lutz (Mem. Inst. Oswaldo Cruz, 27:50, 1933) in a review of trematode larvae occurring in frogs, snakes, and mammals, *Agamodistomum suis* Stiles, 1898, occurring in hogs, is most similar to the specimen found in the rat. The other species considered in the review are all Strigeata and are readily distinguished from *A. suis,* one of the Distomata. The rat metacercaria is different from the one found in hogs primarily in that (1) the former is broader in proportion to its length, (2) it has considerably longer intestinal cruri, and (3) in the location of the primordia of the reproductive system. These differences are considered to be of specific significance and, in view of these facts the specimen described in this paper is considered as new.

The writer wishes to acknowledge with gratitude information and suggestions received from Dr. Wm. A. Riley, University of Minnesota, in connection with the writing of this paper.—S. L. Loewen, Sterling College, Sterling, Kans.

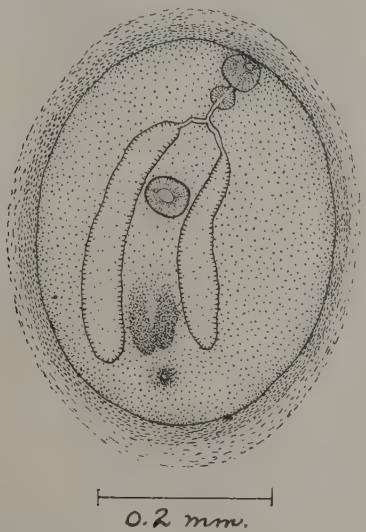


Fig. 1. *Agamodistomum norvegicum* n. sp., ventral aspect, showing the cyst wall.

COCCIDIA OF MARTENS AND SABLES

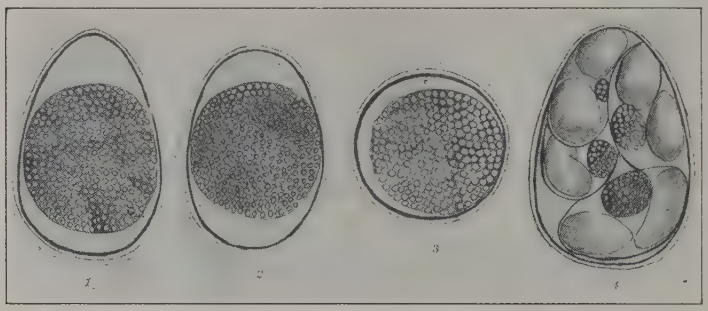
In 1930 Yakimoff and Terwinsky (Arch. Protist., 73:56, 1930) described a coccidium in a sable of Siberia (*Martes zibelina*). The oöcysts were oval, had a double-contoured membrane, and were 40 μ in diameter. The authors named this coccidium *Eimeria sibirica.*

In 1933 we examined the faeces of 17 mammals and 7 apes in the Zoological Garden in Baku (Azerbaidschan; Transcaucase). We found coccidia in two species of Carnivora in the family Mustelidae—a marten (*Martes martes*) and a sable (*Martes zibelina*).

The coccidium of the marten. The following measurements were obtained from 101 oöcysts: largest, 30.6 μ × 19.8 μ; the smallest, 19.8 μ × 16.2 μ, and the average, 21.6 μ × 18.0 μ. The average ratio of length to breadth was 1:0.76.

Some oöcysts immersed in 5 per cent. potassium dichromate at 16° C. contained 4 sporoblasts in 24 hours, and 73 per cent of them contained sporoblasts in 48 hours. Later, spores and sporozoites developed. The sporoblasts were 7.2 μ in diameter and the sporozoites 12.6 μ × 6.0 μ. Residual bodies were present in the sporocysts but not in the oöcysts.

The coccidium of the sable. The following measurements were obtained from 50 oöcysts: largest, 25.2 μ × 18.0 μ; the smallest, 19.8 μ × 16.2 μ; and the average, 21.6 μ × 18.0 μ. The average ratio of length to breadth was 1 : 0.76. A comparison of the coccidia from this sable with those previously described as *Eimeria sibirica* reveals no differences.—W. L. Yakimoff and W. F. Gousseff, Laboratory of Parasitology, Veterinary School, Leningrad.



Explanation of Figures

Oöcysts from the marten. 1. Oviform specimen. 2. Oval specimen. 3. Round specimen. 4. Oöcyst containing spores and sporozoites.

EIMERIA MUSTELAE, N. SP. FROM *MUSTELA VISON*

In the summer of 1933 carcasses and faeces of mink which had died from enteric coccidiosis were obtained from ranches in Canada and the United States. The protozoan responsible for the disease is a hitherto undescribed species of an *Eimeria*.

Description. Oöcysts oval, egg-shaped. Wall double; yellowish-brown inner layer thicker than colorless external membrane; average thickness of wall 0.75 μ. No micropyle. Size ranges from 17.0–22.1 μ × 9.0–18.0 μ; average of 100 oöcysts 20.3 × 14.6 μ. Zygote, 12.0 × 9.0 μ.

In 2.5 per cent solution of potassium bichromate at room temperature majority sporulate on seventh day. Four sporoblasts. Sporocysts at first oval, finally pear-shaped, 10.0 × 5.5 μ; no micropyle. Two sporozoites, 9.1 × 2.5 μ, slightly curved, club-shaped and tapered at one extremity, each lying in opposite direction to its fellow; residual body always present in sporocysts but only in some oöcysts.

Experimental animals, which by repeated faecal tests appeared free from Coccidia, were fed numbers of oöcysts. Six days later a mink and two ferrets commenced to pass oöcysts which disappeared entirely after four days. Two kittens, a rabbit and guinea-pig failed to become infected with the same material. These experiments were repeated three times and the results observed were constant. Thus, this species appears to be distinct from *E. felina, E. perforans* and *E. caviae*, besides varying in morphological details and the periods required for sporulation. It differs from *E. ictidea* of the ferret in that all the stages of its

extracorporeal development are smaller in size; a micropyle is never present, a small residual body occurs in many oöcysts and the period of sporulation is usually seven in place of three days.

It appears that this coccidium which infects the mink (*Mustela vison*) and the ferret (*Mustela putoris* var. *furo*) is a distinct species and the name *Eimeria mustelae* is proposed.—A. A. Kingscote, *Ontario Veterinary College, Guelph, Canada.*

THE DIAGNOSIS OF INTESTINAL PROTOZOA FROM PURGED AND NORMALLY-PASSED STOOLS

In order to test the comparative value of purged and normally passed stools in the diagnosis of human intestinal protozoa the following observations were made. Series of at least six normal stools passed on different days were examined by the simple smear technique in saline and iodine solution. Then a saline cathartic was administered and the resulting purged stool was similarly examined.

In 24 of the 50 persons examined no protozoa were found at any time. The incidence of persons carrying one or more species of intestinal protozoa was, therefore, 52 per cent.

Results are indicated below. The number of protozoan species harbored by positive individuals as determined each day is shown together with the total of newly-detected protozoan species as they accumulated from day to day.

	1st	2nd	3rd	4th	5th	6th	Purge	Total
Number of protozoan species found in all positive individuals each day	14	15	19	18	20	18	32	36
Percent of total in 26 persons	*38.9*	*41.7*	*52.8*	*50.0*	*55.6*	*50.0*	*88.9*	
Accumulated totals including newly detected protozoan species, at the end of each day	14	16	20	24	26	27	36	36
Percent of total in 26 persons	*38.9*	*44.4*	*55.6*	*66.7*	*72.2*	*75.0*	*100.0*	

To further elucidate the information contained in this tabulation, the following expansion of some of the items is given as exemplary of the remainder. As shown above, 14 species of protozoa were discovered at the first examination. These occurred in 12 of the 26 persons eventually found to be positive. Two of these individuals harbored two species each; the remainder of the infections were single. On the second day 15 species (2 double and 11 single infections) were found in 13 persons. Eleven of these had been found positive on the previous examination. Organisms were not found in one individual who had been previously positive, and two persons in whom no organisms had thus far been found were positive at this examination. Accordingly, at the end of the second day 16 (44.4 per cent) of the total of 36 species harbored by the 26 positive persons had been found. The increase in the daily frequency of species as the examinations progressed undoubtedly reflects the influence of knowledge of preceding examinations. The earlier figures are, therefore, probably more truly representative of the percentage of total positives found in this laboratory at a single examination of a normally passed stool. Statistically the daily frequencies did not differ significantly from each other (averaged 51.5 per cent) but were significantly different from the frequency of the purged specimens.

The accumulated total of the species harbored by all positive individuals determined as the result of six normal stool examinations was not significantly dif-

ferent from the number found in the purged specimens. The six examinations of normal stools detected 75 per cent of all the protozoan species found in the normal and purged stools; the single purged specimen showed 88.9 per cent, adding nine species which had not been previously found, and missing four species which had appeared in the normal stools.

The 36 protozoan species were distributed among the 26 positive individuals as follows: single infections, 2 *E. histolytica,* 5 *E. coli,* 6 *E. nana,* 1 *D. fragilis,* 2 *T. hominis,* and 3 *G. lamblia;* double infections, 2 *E. histolytica* and *E. coli,* one *E. histolytica* and *I. williamsi,* and one *I. williamsi* and *G. lamblia*; triple infections 2 *E. coli, E. nana,* and *D. fragilis,* and one *E. coli, E. nana,* and *G. lamblia.*

These results compare favorably with previously published investigations of this kind and serve to emphasize the fact that either a multiplicity of normal stool examinations must be made or that a purged specimen must be examined in order to detect the majority of colonizations by intestinal protozoa. It is believed that the examination of single purged stools reveals, conservatively estimated, at least 75 per cent of the protozoan species which might be ultimately discovered.—JUSTIN ANDREWS, *Department of Protozoology, the Johns Hopkins School of Hygiene and Public Health.*

AMERICAN SOCIETY OF PARASITOLOGISTS

Ninth Annual Meeting, Boston, Massachusetts, December 28, 29, and 30, 1933

The American Society of Parasitologists held its ninth annual meeting on Thursday, Friday and Saturday, under the presidency of Dr. William H. Taliaferro. The program contained 80 titles, and 37 of these papers were presented, either orally or by demonstration. The first three sessions were devoted to papers of general and biological interest, arranged according to subject, protozoology, helminthology and entomology. Researches on the morphology, life history, physiology and control of these parasites were reported. Several of the papers dealt with susceptibility and resistance to animal parasites. Friday noon 67 members of the society met for luncheon at the Harvard Faculty Club, and the annual business meeting of the society was held after the luncheon. Friday afternoon was reserved for the annual demonstration program, an outstanding feature of the meeting which has received increased attention in recent years. The demonstrations consisted of charts, photographs and both living and mounted specimens. Dr. Strong presented his recent studies on *Onchocerca,* and Dr. Alicata a new method for sex differentiation in certain larval nematodes. The structure and developmental stages of various other parasitic worms were shown. Among the *Entamoeba* demonstrations, one by Dr. Stabler of a species parasitic in the ciliate *Zelleriella* attracted much attention. The Saturday program was devoted to medical parasitology and was held jointly with the Section on Medical Sciences (N) of the association. The morning session closed with the presidential address on "Some Cellular Bases for Immunological Processes in Parasitic Infections." Dr. Taliaferro presented an incisive analysis of immunological reactions and the results of his recent studies on malaria in birds and monkeys. The Saturday afternoon session was devoted to a symposium on the typhus group of organisms. Invited papers dealing with different aspects of the subject were presented by Drs. Zinsser, Pinkerton, Wolbach and Hertig (Harvard Medical School), and a paper by Dr. R. R. Parker (Rocky Mountain Spotted Fever Laboratory, U. S. Public Health Service) was read by Dr. Wolbach. Dr. Tyzzer opened the discussion after the presentation of the invited papers.

The twenty-second meeting of the Council was held on Wednesday afternoon, December 28th at the Hotel Statler, Boston, with an adjourned session Thursday afternoon in Pierce Hall, Harvard. Items of business:

1. The president reported on the appointment of Dr. John Guberlet as representative of the Society to the Fifth Pacific Congress.

2. The reports of the secretary and treasurer were received. N. R. Stoll and H. W. Stunkard were appointed as an auditing committee to examine the treasurer's report. On approval by the auditing committee, the reports of secretary and treasurer were approved and placed on file.

3. Dr. Stoll reported on the status of the "secretarial fund" which amounts to $261.46. On motion it was voted that this "fund" be maintained as a definite entity to be dispensed only at the discretion and behest of Council and Dr. Stoll was elected custodian of the fund.

4. Twelve applicants were elected to membership in the Society.

5. The reports of the editorial committee and committee on necrology were presented for Dr. Cort by the treasurer.

6. It was voted that a roll of members of the Society be published as a part of the program and abstracts of the 1934 meeting, and that any expenses over and above the customary $100 allotted for this number be borne by the Journal of Parasitology.

7. It was voted that the Journal of Parasitology should not be sent to members in arrears and that members in arrears for more than one year be dropped from the roll of the Society. After discussion it was voted that the present $6.00 fee to accompany application be continued.

8. It was voted that the Council does not approve an agreement for a Parasitologists' Exchange proposed by the General Biological Supply House.

9. Council passed a resolution expressing regret at the contemplated discontinuance of the Proceedings of the Helminthological Society of Washington.

10. The secretary was authorized to appoint representatives of the Society to the committee of the Council of the American Association for the Advancement of Science and to the American Biological Societies for 1934.

11. The Council voted unanimously on a list of nominees to be presented to the annual business meeting of the Society.

12. Following the Council meeting, the annual dinner given by the president to Council and former presidents was held at the Hotel Statler.

The ninth annual business meeting of the Society was held on Friday, December 29th at 2:30 P. M. at the Faculty Club of Harvard University. Sixty-seven members were present. An abstract of the minutes of the eighth annual meeting held at Atlantic City, and report on the action of Council taken by mail, were read and approved.

The secretary reported the election of six candidates to membership in the Society, and the election of Drs. Craig, Faust, and Schwartz to succeed Drs. Craig, Hall, and Ward on the editorial board of the Journal of Parasitology.

The Council approved the action of the secretary in appointing Drs. George R. La Rue and E. E. Tyzzer as representatives of the Society to Council of the A. A. A. S., and Drs. R. P. Strong and D. H. Wenrich to Council of the U. A. B. S.

Membership in the Society as of December 6, 1933, totals 420. There are 2 life and 11 foreign honorary members. Loss in membership during the year amounted to 70, of which 4 were occasioned by death. Report of the secretary was accepted and placed on file.

Report of the treasurer for the fiscal year 1933 as of the close of business December 19th, 1933, was presented. The report had previously been certified as correct by Drs. N. R. Stoll and H. W. Stunkard. Receipts for the year totaled $1,325.36, with a deficit at the end of the year of 28 cents. Funds still impounded in closed banks total $236.98. Dues paid for 1934 and in advance, $789.32. Bills payable $225.26. Balance in bank $564.06. The report of the treasurer was adopted and placed on file.

Report of the editorial committee of the Journal of Parasitology was presented for the committee by Dr. Justin Andrews. The editorial committee has arranged to publish Volume 20 in six numbers, and is attempting to increase the subscription in order that the increased cost of publication may be met. For many years an informal arrangement has existed between the Journal of Parasitology and the Helminthological Society of Washington whereby the Proceedings of the Society have been published in the Journal. During the past year the amount of material in the Proceedings has increased to such an extent that the Journal has found difficulty in handling it. The editorial committee proposed, therefore, that the Helminthological Society pay a part of the cost of printing the Proceedings. The Society preferred, however, to attempt the publication of its own proceedings and the editorial committee is sorry to lose this material since it is of wide interest to parasitologists. The editorial committee reports the establishment of a new section called "Research Notes" for short articles. The committee reported further that manuscripts are now accepted for publication to complete Volume 20 and part of 21. Papers accepted now can not appear until 1936. The report of the editorial committee was discussed at some length and in order to provide for more prompt publication

the Society voted that the Council be instructed to take steps necessary to increase the annual dues to $4.00 of which $3.00 shall go to the Journal of Parasitology.

Report of the committee on necrology, W. W. Cort, Chairman, was presented by the secretary. Appropriate notes were entered in the records of the Society on the deaths of Professor Friedrich Fülleborn, foreign honorary member, Dr. John E. Stumberg of the Department of Animal Pathology at the Rockefeller Institute, Princeton, N. J., Dr. Hou Ki Hu, Commissioner of Public Health of the Muncipality of Greater Shanghai, Mrs. Dorothy Koch Donaldson, former member of the Pacific Institute of Tropical Medicine, and Dr. Nelson C. Davis, member of the field staff of the International Health Division of the Rockefeller Foundation. A note on the life and work of Professor Fülleborn has been prepared by the secretary. The report of the committee on necrology was adopted and placed on file.

There was no report from the committee on nomenclature, Dr. G. Steiner, Chairman.

The report of the representatives of the A. S. P. on the Council of the A. A. A. S., presented by Dr. E. E. Tyzzer, was accepted and placed on file.

The report of the representatives of the A. S. P. on the Council of the U. A. B. S., made by Dr. D. H. Wenrich, was adopted and filed.

It was voted that the new president be empowered to appoint a committee for the consideration of certain questions in terminology in parasitology. The motion was passed.

The secretary presented the unanimous recommendation of Council for nomination of officers for the year 1934. For president, E. E. Tyzzer, Harvard University; for vice-president, J. E. Ackert, Kansas State College; for Council members at large for four years, Eloise B. Cram, U. S. Department of Agriculture, Washington, D. C., W. A. Sawyer of the Rockefeller Foundation, New York. No further nominations were made and the secretary was instructed to cast one ballot for the election of the nominees.

On motion the Society extended a vote of thanks to Professor Tyzzer and the group from Harvard Medical School for their contribution to the annual program. The Society also voted an expression of thanks to Doctor Augustine, local representative of the Boston meeting, and to the treasurer and secretary for their services during the year.

On motion the Society voted to adjourn until the tenth annual meeting to be held at Christmas time in Pittsburgh.

Respectfully submitted,
H. W. Stunkard, Secretary.

SUBSEQUENT ITEMS

On January 8th Professor Hegner resigned as a member of the Editorial Committee of the Journal of Parasitology. The Secretary reported this resignation to Council and asked for nominations. The suggestion was made that a protozoologist from the Editorial Board be elected to the Editorial Committee and a successor elected for the member of the Board. Of the nominations, Drs. Taliaferro and Wenrich received the largest number of votes as nominees to the committee and Drs. Becker and Cleveland as new members of the Editorial Board. These names were resubmitted to Council and Dr. Taliaferro was elected a member of the Editorial Committee and Dr. Becker as the new member of the Editorial Board.

President Tyzzer has appointed the members of the committee on terminology: Dr. Marshall Hertig, Chairman, Drs. Benjamin Schwartz and W. H. Taliaferro. Members of the Society may refer any question of terminology to a member of the commitee.

The Editorial Committee has requested the Council to increase the cost of subscriptions to the Journal from $3.00 to $4.00 so that the subscription charge will be the same as the annual dues. Council has voted affirmatively on this request.

Two additional members were elected to the Society by mail vote of Council since the annual meeting.

A request was made by the officers of the A. A. A. S. and endorsed by certain members that the Society hold a program meeting June 18th to 23rd at Berkeley, in connection with the summer meeting of A. A. A. S. The question was referred to Council for vote and failed to receive a sufficiently large number of votes to authorize the meeting. Members of Council expressed their sympathy with the proposal, but felt that it was not advisable at this time.